MANATEE HARBOR, FLORIDA
LIMITED REEVALUATION REPORT

APPENDIX A
Economics

Manatee Harbor Limited Reevaluation Report
Appendix A. Economics

PURPOSE AND SCOPE

This economics appendix was developed to support the Manatee Harbor LRR and PAC by updating 1) light-loading cost reduction benefits (and benefits during construction) for Phase I deepening and 2) delay cost reduction benefits of the alternative plans for channel wideners and a turning basin at Port Manatee (Phase II).

The economic analyses were developed by the Jacksonville District, with significant assistance from David Miller & Associates (DMA) and CDM. Economic analyses documented in this appendix were conducted consistent with the Planning Guidance Notebook, Engineering Regulation (ER) 1105-2-100 (22 April 2000), and other Corps guidance, such as the National Economic Development Procedures Manual: Deep Draft Navigation (IWR Report 91-R-13, November 1991).

BACKGROUND

Port Manatee, which is owned and operated by Manatee County Port Authority (MCPA), commenced operations in 1970. The Port initially served as a barge facility for bulk commodities. To provide access for commercial navigation, MCPA constructed the Port Manatee Channel, which extends approximately 15,850 feet in length from the Port harbor to the Tampa Bay Channel. Federal involvement in the Port Manatee Channel commenced in 1974, when Congress requested a review of the Tampa Harbor project. Based on the findings of that review, the Port Manatee Channel was adopted as a Federal channel subject to Federal maintenance. Congress authorized the Port Manatee project in the Water Resources Development Act (WRDA) of 1986. The authorized project provides for Federal maintenance of an existing channel, construction of wideners at the entrance channel and expansion of the existing turning basin. Maintenance of the channel is authorized to a depth of 40 feet mean low water (MLW) and a width of 400 feet.

WRDA 1990 (PL 101-640) modified the project through a Post Authorization Change (PAC) dated April 1990. To accommodate the funding capability of the MCPA, the PAC recommended performing this work in two phases. Phase I would address the widening and deepening component, and Phase II would evaluate turn wideners, an improved turning basin, and associated mitigation. A 1993 Limited Reevaluation Report (LRR) updated the cost and benefits of the refined detailed design developed during the preparation of the PAC. Phase I consisted of an entrance channel, extending from the main Tampa Harbor channel to the Port Manatee Harbor, with a length of 15,850 feet and a width of 400 feet at a depth of 40 feet MLW. Phase I was completed in December 1996.

The Phase II recommendation for the 900-foot turning basin was not implemented due to environmental concerns related to seagrass disturbance south of the channel's southern boundary as it enters the harbor. An Engineering Documentation Report (EDR), dated December 2001, was prepared to document the design and cost for Phase II for a modified turning basin. The EDR Phase II provided revised engineering design and construction cost estimates for: (1)

wideners for the Port Manatee Channel at its intersection with the Tampa Harbor Channel and (2) relocation of the authorized 900-foot diameter, 40 feet MLW turning basin. The revised design located the turning basin north of the channel, tangential to the northern edge of the channel as it enters the harbor. This would effectively provide a 1,300' x 900' turning area. Based on the differences between the revised turning basin design and the authorized turning basin, the Corps determined that this LRR (and subsequent PAC) would be required for a recommendation for Phase II construction. The purposes of this LRR and PAC are to provide a current estimate of project benefits (Phases I and II) and evaluate the engineering, economic, and environmental feasibility of the proposed Phase II navigation improvements.

Changes Since the January 1994 LRR

The Limited Re-evaluation Report (LRR) for Manatee Harbor, completed by the Jacksonville District in January 1994, served as an update of the economics presented in the April 1990 Post-Authorization Change (PAC) Report. The LRR analysis supported the recommendation that improvements should be constructed in two phases:

1.) Phase 1 – Deepening of the Port Manatee Channel to a depth of 40 feet (completed in December 1996).

2.) Phase II - Excavation of extended widening at the confluence of Tampa and Port Manatee Channels coupled with realignment and enlargement of the vessel turning basin to a 900' diameter and a depth equal to that of Port Manatee Channel.

Vessel fleets with, and without project implementation were expected to remain comparable relative to vessel class. Study findings indicated that transition to larger draft vessels had generally already occurred with the initial increase in controlling depth to 37.0 feet. A comparatively smaller incremental increase in controlling depth with project implementation (i.e., to a depth of 40.0 feet referenced to MLW) did not support a significant change in overall fleet composition for the future. The LRR revealed that project benefits would most likely be derived from elimination of channel access delays. Related implications are that a relatively smaller proportion of any future fleet will be favorably impacted by project construction. It was determined many vessels incurring channel access delays would not realize benefits from reductions in light loading with project construction. Therefore, a greater proportion of fleet composition was assessed only channel access delay benefits as opposed to benefits from reduction of light loading.

Table A-1 displays annual traffic (by fiscal year) at Port Manatee by major commodity classification since the completion of the LRR (base year traffic patterns derived from 1991 and earlier data). While traffic declined slightly during the intervening years, in 1999 and 2001, it recovered to recent record levels. The composition of Port Manatee traffic has changed, however. In 1991, liquid bulk commodities comprised almost 70 percent of total traffic; by 2002, its share had decreased to 43 percent.

Table A-1
Port Manatee Commodity Traffic, Fiscal Years 1991-2002
(Tons in Thousands)

	Liquid Bulk	Dry Bulk	General Cargo	Total
1991	3,380	1,103	391	4,874
1992	3,428	1,400	475	5,303
1993	2,835	981	499	4,315
1994	2,858	1,771	579	5,208
1995	1,833	1,893	600	4,326
1996	1,939	1,791	454	4,184
1997	1,585	2,134	559	4,278
1998	2,278	1,984	642	4,904
1999	2,423	2,520	588	5,531
2000	1,957	1,613	536	4,106
2001	2,411	2,520	662	5,593
2002	2,177	2,162	709	5,048
Ave. Ann. % Growth	-4.26%	6.89%	6.07%	0.35%

In FY2002, commodity tonnage moved through Port Manatee facilities totaled an estimated 5.0 million short tons. The total includes more than thirty different commodity classifications moving in a variety of vessel types. According to forecasts developed for the January 1994 LRR, by 2002, more than 6.2 million tons of cargo (74 percent liquid bulk commodity tonnage) were expected to benefit from the project, as authorized. Referencing actual tonnage movements at Port Manatee in 2002, approximately 5.0 million tons of traffic would have benefited from extended channel widening. The difference of 1.2 million tons, represents a shortfall of 20 percent. Current commodity traffic is composed largely of dry bulk and general cargo commodities, though liquid bulk is still an important component of Port Manatee commodity traffic.

Developments affecting assessment of project benefits also include a decrease in the interest rate used for discounting of future benefit valuations by year. The applied rate has decreased from 8 7/8 percent in FY 1990, to a level of 5 7/8 percent in FY 2003. The net impact of described developments in combination with other factors has resulted in a reduction of calculated benefits from a value of $7,874,000 in 1994 to $ 5,300,693 in 2003. This equates to a percentage decrease of approximately 33 percent.

Figure A-1 contains a comparison of the assumptions and prevailing conditions of both analyses. A number of differences can be distinguished that result in a different, i.e. lower, estimate of project benefits. The shift in the commodity distribution from liquid bulk toward dry bulk and general cargo has resulted in lower-cost vessels frequenting the port.

Manatee Harbor LRR Phases I and II Analysis Parameters (Jan 1994 vs. May 2003)		
	LRR Jan 1994 (FY1993 dollars)	**LRR May 2003 (FY2003 dollars)**
Phase I		
Deepening to 40'		
-- Fleet Composition	Liquid bulk (US and foreign-flagged) predominant vessel	Dry bulk and general cargo (foreign-flagged) predominant vessels
** Implications of Fleet Composition	Expensive vessels making relatively short trips	Lower cost vessels making longer trips
-- W/O Project Channel Condition	37' channel depth; existing 750' turning area; no new berths	37' channel depth; existing 750' turning area; no new berths
-- Improved Condition (With Project)	40' channel depth	40' channel depth
Phase II		
Delay Reduction through Turning Basin Expansion and Widener Construction		
-- Fleet Composition	Liquid bulk (US and foreign-flagged) predominant vessel	Dry bulk and general cargo (foreign-flagged) predominant vessels
** Implications of Fleet Composition	Expensive hourly operating costs result in significant costs for delay	Less expensive (-67%) hourly operating costs result in lower costs for delay
-- W/O Project Channel Condition	37' channel depth; existing 750' turning area; no new berths; widener area constrains channel entrance/exit to slack tide for all vessels drafting >= 27'	37' channel depth; existing 750' turning area; no new berths; widener area constrains channel entrance/exit to slack tide for all vessels drafting >= 27'
-- Improved Condition (With Project)	40' channel depth; 900' turning basin; widener construction removes all restrictions allowing 24-hour access.	40' channel depth; 900' turning basin; widener construction eases restrictions only for vessels drafting <= 34'
** Implications of Improved Condition	No vessels are delayed waiting for slack tide	Vessels drafting > 34' are still delayed waiting for slack tide; Port Configuration has insufficient capacity to accommodate forecast traffic.
Phase I and II Combined		
Deepening to 40' and Delay Reduction through Turning Basin Expansion and Widener Construction		
-- First Costs Construction	$30,515,000	$41,547,244
-- AAE Benefits	$7,912,000	$4,949,223
-- AAE Costs	$4,926,000	$4,644,313
-- Benefit:Cost Ratio	1.6	1.1

Consequently the value of their delay is lower, and remedial measures to reduce it produce lower benefits. Furthermore, the LRR analysis assumed that the widener construction would ease all tidal restrictions at Port Manatee, essentially allowing 24-hour port access. The Tampa Bay Pilots' Association (TBPA) have since indicated that restrictions for a slack tide channel entrance/egress would remain in place for all vessels drafting 34' or more (the largest and most expensive vessels in the fleet), and delays for these vessels would still occur.

EVALUATED ALTERNATIVES

Updated estimates of the benefits for Phases I and II will be presented as 1) light-loading cost reduction benefits pre-base year 2005, i.e. benefits during construction; 2) light-loading cost reduction benefits; and 3) delay cost reduction benefits. Both analyses are documented beyond the scope of an LRR and are attached as addendums for detailed explanation of the underlying assumptions and methodologies (Addendum I. Light-loading Cost Reduction Benefits, and Addendum II. Delay Cost Reduction Benefits). The benefits of navigation improvements under consideration in this investigation are based on savings in transportation cost to the nation. The benefits of the improvements are estimated by comparing transportation costs under with- and without-project conditions for the 50-year period of analysis (2005 – 2054).

The alternative plans considered in this analysis combine deepening of the project to 40' (MLLW) and channel wideners at the entrance to the Port Manatee Channel with four turning basin configurations. A single widener design is under consideration, which was developed using ship simulation analyses conducted by the Corps Waterways Experiment Station (with extensive input from the Tampa Pilots Association). As part of the with-project conditions, the Port Manatee Channel and harbor is assumed to remain at the authorized 40-foot MLW depth. The following turning basin configurations are under consideration in combination with the wideners:

A-3. 900-foot turning basin tangent to the south side of the channel.

A-7. 900-foot turning basin tangent to -100' from the north side of the channel (effective 1200'x 900')

A-4. 900-foot turning basin tangent to the north side of the channel in front of berths 4 and 5 (as recommended in a previous EDR 1300' x 900').

A-6. 1,200-foot turning basin tangent to the south side of the channel.

For with-project conditions, some analytical inputs were the same as those used for without-project conditions; others differed. The analytical inputs that are the same as without-project conditions include: Port facilities, Port operating practices and constraints, mix of vessels, and commodity forecasts. The analytical inputs that are differ from without-project conditions include the number of vessels calling at the Port and anticipated navigation practices with wideners and the alternative turning basin configurations. These departures from without-project conditions are the basis for estimating the benefits of the alternative plans.

Under with-project conditions, the depth of the Port Manatee Channel and harbor is assumed to be 40 feet. This allows some vessels in the Port Manatee fleet to be more fully loaded than under without-project conditions. As a result, the vessels that are restricted by the without-project channel depths can carry more tonnage under with-project conditions. The forecasted volume and mix of commodities was distributed to vessels carrying tonnages consistent with the average tonnage per vessel, applying the commodity-to-vessel distribution.

Existing and Forecast Commodity Traffic

The benefits of navigation improvements to Port Manatee are based, in part, on the volume and mix of commodities anticipated to pass through the Port. The types and volume of commodities moved through Port Manatee are the main determinant of the types and number of vessels calling at the port. Commodity forecasts used in the benefit analysis are based on growth rates developed by the Jacksonville District staff based on historical growth at Port Manatee, and industry expert projected growth rates for various commodities within specific trade regions.

Table A-2 shows the 20 main commodity types handled at Port Manatee. These 20 commodity types also are used to characterize the existing fleet. The "miscellaneous" category includes commodities identified as such in the Port's data set. The "other" category includes a mix of commodities that constitute a very small portion of the total traffic through the Port.

Table A-2
Historical Commodity Categories

Aggregate	Forest Products
Asphalt	Fresh Fruit
Bagged Fertilizer	Granite
Bulk Fertilizer	Limestone
Bunker Fuel	Linerboard
Cement	Miscellaneous
Cement Clinker	Not Concentrated Juice
Concentrated Juice	Other
Diesel Fuel	Passengers
Dolomite	Steel

A representative base year was calculated with the most recent data and includes the recent reduction in commodity movements experienced in the year 2000. The commodity forecasts do not include non-recurring traffic, such as the existing steel pipe and bridge steel deliveries occurring at the port for off-site construction projects.

Growth rates were applied to the base year estimates to project future commodity traffic in the port. The base year (2005) of commodity projections were calculated by multiplying 2001 commodity volumes (actual) for each vessel type by the growth rates generated by the District. Projections for subsequent years were calculated by multiplying the annual tonnage for each vessel type by the growth rate. Due to the considerable uncertainty associated with a commodity forecast that extends to the year 2054 (the end of the period of analysis), projected commodity tonnages are held constant from year 2022 (17 years into the period of analysis) for the remaining 32 years of the period of analysis. **Table A-3** shows the calculated base year and commodity forecasts for selected years. Note that the limestone tonnage growth evidenced in Table 3 reflects the expected annual volume of a new movement.

It is assumed that under without-project conditions the volumes and mix of commodities in the above forecast will be carried on the mix of vessels profiled in **Table A-4**. However, under without project conditions, channel depths in the Port Manatee Channel and in the harbor are assumed to be constrained to 37 feet, consistent with the pre-Phase I project depth. This would require sailing drafts of the existing fleet to be constrained to 34 feet, allowing three feet of underkeel clearance.

Table A-3
Base Year Commodity Data and Commodity Forecast
(With- and Without-Project Conditions)

Commodity Type	2001 Actual	2005 Base Year	2007	2012	2017	2022
Aggregate	160,355	227,101	286,404	286,404	286,404	286,404
Asphalt	105,857	108,740	110,707	115,779	121,084	126,631
Bagged Fertilizer	1,806	2,308	2,308	2,308	2,308	2,308
Bunker Fuel	1,601,425	1,679,530	1,733,705	1,876,912	2,031,947	2,199,788
Cement	283,497	297,324	306,914	332,266	359,712	389,424
Clinkers	423,335	443,983	458,304	496,160	537,144	581,513
Conc Juice	55,220	65,433	73,271	97,223	129,006	171,178
Diesel Fuel	74,885	77,614	79,488	84,373	89,558	95,062
Dolomite	175,592	197,119	212,917	258,176	313,055	379,599
Bulk Fertilizer	644,642	823,880	823,880	823,880	823,880	823,880
Forest Products	100,347	162,578	224,268	224,268	224,268	224,268
Fresh Fruit	304,340	334,794	356,771	418,233	490,285	574,749
Granite	27,368	36,080	43,379	43,379	43,379	43,379
Limestone	68,984	500,000	500,000	500,000	500,000	500,000
Linerboard	50,066	84,626	120,080	120,080	120,080	120,080
Miscellaneous	35,198	90,507	169,873	169,873	169,873	169,873
Juice Not Concentrate	151,142	166,265	177,180	207,703	243,485	285,432
Other	56,651	74,686	89,796	89,796	89,796	89,796
Steel	15,786	26,469	37,356	37,356	37,356	37,356
Totals	4,336,498	5,399,037	5,806,602	6,184,171	6,612,620	7,100,721

Table A-4
Existing Fleet: Vessel Categories and Sizes

Commodity Class	Ship Type	LOA	Draft	DWT
	Barge I	240	NR	3,100
Aggregate	Barge II	250	NR	3,100
	Barge I	416	24	10,799
	Barge II	469	31	16,304
Asphalt	Self-Propelled I	595	36	36,922
Bag Fertilizer	Barge I	195	NR	3,100
	Barge I	192	NR	758
	Barge II	449	33	14,037
	Barge III	489	37	18,819
	Self-Propelled I	586	36	35,107
	Self-Propelled II	731	39	74,709
	Self-Propelled III	683	35	59,153
Bunker	Self-Propelled IV	797	38	79,133
	Self-Propelled I	550	39	3,000
Cement	Self-Propelled II	615	39	3,000
	Self-Propelled I	583	38	26,097
Clinker	Self-Propelled II	620	38	31,625
	Self-Propelled I	555	29	29,071
Juice Concentrate	Self-Propelled II	546	33	27,484
	Barge I	506	31	21,163
Diesel	Self-Propelled I	606	36	39,320
	Barge I	229	NR	3,000
Dolomite	Barge II	243	NR	3,000
	Barge I	439	26	3,000
	Barge II	590	32	3,000
	Self-Propelled I	385	34	7,619
	Self-Propelled II	585	39	28,696
Fertilizer	Self-Propelled II	797	40	54,252
	Self-Propelled I	365	29	6,419
	Self-Propelled II	518	31	20,601
	Self-Propelled III	596	39	32,744
Forest Products	Self-Propelled IV	665	29	47,249
	Self-Propelled I	443	30	11,073
Fruit	Self-Propelled II	524	30	18,704
Granite	Self-Propelled I	736	29	54,023
Limestone	Self-Propelled I	797	40	53,111
	Self-Propelled I	426	28	9,799
Linerboard	Self-Propelled II	533	28	19,725
	Self-Propelled I	370	28	6,311
	Self-Propelled II	553	38	22,129
Miscellaneous	Self-Propelled III	610	38	30,059
	Self-Propelled I	499	30	16,056
Juice Not Concentrate	Self-Propelled II	498	32	15,956
	Barge I	168	20	3,100
	Barge II	420	20	3,100
	Self-Propelled I	359	32	5,744
Other	Self-Propelled II	567	34	23,926
Cruise Passengers	Cruise Vessel	611	26	40,446
	Barge I	195	NR	3,000
Steel	Self-Propelled I	527	34	19,040

Characteristics of the existing fleet were used to forecast future fleet characteristics. The projected future fleet maintains most of the characteristics of the existing fleet including vessel type and length. Sailing drafts are constrained by channel dimensions assumed under without-project conditions. The projected number of port calls is based on the portion of tonnage carried by the various vessel types and the growth of commodity traffic.

The without-project fleet forecast was generated by calculating annual tonnage for each of the 50 vessel types for a representative base year derived from 1999 – August 2001 data. Because there are no major changes expected in the types of commodities moving through the port, there are no major changes in vessel types projected for the fleet. Port data from 1990 through 2000 indicates a trend of increasing vessel size (length and sailing draft), but this trend was not applied to the projected fleet because of limited information to describe the trend, uncertainty over whether the trend would continue, and port physical limitations. Commodity deliveries known to have a specific termination date, such as the steel pipe deliveries for a local pipeline construction project and steel deliveries for a local bridge construction project, were not included in the commodity or fleet projections. Calls that for whatever reason did not have sufficient data, such as missing tonnage or vessel length information were not included in the fleet forecast. Also, tug movements in and out of the port and berth usage by the local yacht manufacturer were not included in the fleet forecasts or in the benefit calculations.

The method used to forecast the characteristics of the future fleet is based on the existing 50 vessel categories, the portion of tonnage carried by each category, and projected commodity movements through the port. Each of the 50 vessel categories was allocated a proportional share of the total tonnage of the commodity traffic related to that vessel category, based on the 1999 – 2001 port data. Average commodity tonnage per call for each vessel category also is calculated from the same port data. The base year tonnage per vessel call is calculated as the weighted average tonnage per vessel call for calls made between January 1999 and August 2001. The base year tonnage per call for each vessel type is multiplied by the base year annual calls for that vessel type to calculate the total base year tonnage for that vessel type. Because the base year is a calculated annual value, not an observed annual value, fractional vessel calls were not rounded. Annual growth rates for specific commodity types identified in the District estimates were applied to the base year, with the exceptions of fertilizer, limestone, and cruise ships. **Table A-5** shows tonnages for each vessel type for the base year and selected forecast years for with- and without-project conditions.

Future vessel calls are projected by distributing projected commodity traffic among vessel categories according to the share allocated to that vessel category[1]. For those commodities that have projected tonnage increases, an additional vessel call is projected when total tonnage allocated to that vessel category increases by 50 percent or more of the average commodity tonnage per call. Due to the considerable uncertainty associated with a fleet forecast that extends to the year 2054 (the end of the study period), projected vessel calls are held constant from year 2024 (20 years into the study period) to year 2054.

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[1] Cruise ships are expected to make 39 calls per year, each year, in accordance with current plans and arrangements with the Port Authority.

Table A-5
Projected Commodities Distributed to Vessels
(With- and Without-Project Conditions)

Commodity Type	Ship Type	Base Year	2005	2007	2012	2017	2022
							Projected Year
Aggregate	Barge I	142,792	202,229	255,036	255,036	255,036	255,036
	Barge II	17,563	24,873	31,368	31,368	31,368	31,368
Asphalt	Barge I	15,470	15,891	16,179	16,920	17,695	18,506
	Barge II	66,092	67,892	69,120	72,287	75,599	79,063
	Self-Propelled I	24,295	24,957	25,408	26,572	27,789	29,063
Bag Fertilizer	Barge I	1,806	2,308	2,308	2,308	2,308	2,308
Bunker	Barge I	18,858	19,778	20,416	22,102	23,928	25,904
	Barge II	278,746	292,341	301,771	326,698	353,684	382,898
	Barge III	216,207	226,752	234,066	253,401	274,332	296,992
	Self-Propelled I	34,513	36,196	37,364	40,450	43,791	47,409
	Self-Propelled II	299,774	314,394	324,536	351,343	380,364	411,782
	Self-Propelled III	68,975	72,339	74,673	80,841	87,518	94,747
	Self-Propelled IV	684,352	717,729	740,880	802,078	868,330	940,056
Cement	Self-Propelled I	109,058	114,377	118,067	127,819	138,377	149,807
	Self-Propelled II	174,439	182,947	188,848	204,447	221,334	239,617
Clinker	Self-Propelled I	222,305	233,148	240,668	260,548	282,069	305,368
	Self-Propelled II	201,030	210,835	217,636	235,613	255,075	276,144
Concrete	Self-Propelled I	7,256	8,598	9,628	12,775	16,951	22,493
	Self-Propelled II	47,964	56,835	63,643	84,448	112,055	148,686
Diesel	Barge I	53,538	55,489	56,829	60,321	64,028	67,963
	Self-Propelled I	21,347	22,125	22,659	24,052	25,530	27,099
Dolomite	Barge I	20,183	22,658	24,473	29,676	35,984	43,632
	Barge II	155,409	174,462	188,444	228,500	277,071	335,966
Fertilizer	Barge I	10,941	13,983	13,983	13,983	13,983	13,983
	Barge II	13,600	17,382	17,382	17,382	17,382	17,382
	Self-Propelled I	158,363	202,395	202,395	202,395	202,395	202,395
	Self-Propelled II	238,065	304,257	304,257	304,257	304,257	304,257
	Self-Propelled II	223,673	285,864	285,864	285,864	285,864	285,864
Forest Products	Self-Propelled I	19,486	31,570	43,550	43,550	43,550	43,550
	Self-Propelled II	18,420	29,843	41,167	41,167	41,167	41,167
	Self-Propelled III	54,985	89,085	122,888	122,888	122,888	122,888
	Self-Propelled IV	7,456	12,080	16,664	16,664	16,664	16,664
Fruit	Self-Propelled I	100,120	110,138	117,368	137,588	161,290	189,077
	Self-Propelled II	204,220	224,655	239,403	280,646	328,994	385,672
Granite	Self-Propelled I	27,368	36,080	43,379	43,379	43,379	43,379
Limestone	Self-Propelled I	68,984	500,000	500,000	500,000	500,000	500,000
Linerboard	Self-Propelled I	30,050	50,793	72,073	72,073	72,073	72,073
	Self-Propelled II	20,016	33,833	48,088	48,088	48,088	48,088
Miscellaneous	Self-Propelled I	896	2,303	4,323	4,323	4,323	4,323
	Self-Propelled II	551	1,417	2,660	2,660	2,660	2,660
	Self-Propelled III	33,751	86,787	162,890	162,890	162,890	162,890
Juice Not Concentrate	Self-Propelled I	100,558	110,620	117,881	138,189	161,996	189,904
	Self-Propelled II	50,584	55,646	59,298	69,514	81,490	95,528
Other	Barge I	272	359	432	432	432	432
	Barge II	3,615	4,766	5,730	5,730	5,730	5,730
	Self-Propelled I	18,459	24,335	29,259	29,259	29,259	29,259
	Self-Propelled II	34,305	45,226	54,375	54,375	54,375	54,375
Passengers	Cruise V	-	-	-	-	-	-
Steel	Barge I	503	843	1,190	1,190	1,190	1,190
	Self-Propelled I	15,283	25,625	36,166	36,166	36,166	36,166
Totals		4,336,498	5,399,037	5,806,602	6,184,171	6,612,620	7,100,721

Hourly vessel operating costs for self-propelled vessels (both in-port and at-sea) were taken from the tables and regressions provided in Economic Guidance Memorandum 02-06, Deep Draft Vessel Operating Costs, adjusted to 2003 levels. Operating costs for barges were taken from Economic Guidance Memorandum 00-05, Shallow Draft Vessel Operating Costs, in lieu of ocean-going barge costs. **Table A-6** shows the hourly vessel operating costs used in this analysis. Additional cost data used in the analysis are based on interviews with Port Manatee tenants and Port staff. capable of servicing the carrier and cargo. Most carriers and vessels are diverted to Tampa, with the exception of Tropicana, Gear Bulk (forest products), and Del Monte (fresh fruit) vessels.

Table A-6
Vessel Costs

Ship Class	Ship Type	EGM 02-06 Designation	Hourly Costs At Sea	In Port
	Barge I	Barge	$634.62	$7.71
Aggregate	Barge II	Barge	$634.62	$7.71
	Barge I	Asphalt barge	$1,412.44	$33.33
	Barge II	Asphalt barge	$1,494.74	$33.33
Asphalt	Self-propelled I	US tanker	$1,720.98	$1,566.43
Bag Fertilizer	Barge I	Barge	$634.62	$7.71
	Barge I	Barge Tanker	$1,064.62	$20.83
	Barge II	Barge tanker	$1,463.68	$20.83
	Barge III	Barge tanker	$1,525.79	$20.83
	Self-Propelled I	FF tanker	$746.79	$594.45
	Self-Propelled II	FF tanker	$953.06	$753.62
	Self-Propelled III	US tanker	$1,956.88	$1,774.17
Bunker	Self-Propelled IV	US tanker	$2,161.67	$1,957.61
	Self-Propelled I	Barge	$564.04	$406.27
Cement	Self-Propelled II	Barge	$605.79	$436.17
	Self-Propelled I	FF Gen Cargo	$596.01	$421.09
Clinker	Self-Propelled II	FF Gen Cargo	$609.64	$438.93
	Self-Propelled I	FF tanker	$716.00	$572.54
Juice Concentrate	Self-Propelled II	FF Tanker	$707.06	$566.18
	Barge I	Barge Tanker	$1,552.19	$20.83
Diesel	Self-Propelled I	US tanker	$1,748.15	$1,590.89
	Barge I	Barge	$634.62	$7.71
Dolomite	Barge II	Barge	$634.62	$7.71
	Barge I	Barge	$634.62	$7.71
	Barge II	Barge	$634.62	$7.71
	Self-Propelled I	FF Gen Cargo	$470.11	$344.11
	Self-Propelled II	FF Gen Cargo	$596.01	$429.17
Fertilizer	Self-Propelled III	FF Gen Cargo	$735.66	$527.01
	Self-Propelled I	FF Bulker	$410.45	$332.91
	Self-Propelled II	FF Bulker	$544.87	$393.56
	Self-Propelled III	FF Bulker	$592.57	$426.71
Forest Products	Self-Propelled IV	FF Bulker	$649.90	$468.70
	Self-Propelled I	FF Gen Cargo	$474.39	$363.52
Fruit	Self-Propelled II	FF Gen Cargo	$663.63	$494.41
Granite	Self-Propelled I	FF Gen Cargo	$979.76	$727.64
Limestone	Self-Propelled I	FF Gen Cargo	$728.13	$521.53
	Self-Propelled I	FF Gen Cargo	$450.82	$349.87
Linerboard	Self-Propelled II	FF Gen Cargo	$692.53	$515.65
	Self-Propelled I	FF Gen Cargo	$373.19	$304.90
	Self-Propelled II	FF Gen Cargo	$761.37	$565.59
Miscellaneous	Self-Propelled III	FF Gen Cargo	$979.76	$727.64
	Self-Propelled I	FF Gen Cargo	$583.37	$435.44
Juice Not Concentrate	Self-Propelled II	FF Gen Cargo	$580.16	$433.08
	Barge I	Barge	$634.62	$7.71
	Barge II	Barge	$634.62	$7.71
	Self-Propelled I	FF Gen Cargo	$357.94	$296.06
Other	Self-Propelled II	FF Gen Cargo	$809.93	$600.76
Cruise Passengers	Cruise Vess	US tanker	$1,760.50	$1,602.01
	Barge I	Barge	$634.62	$7.71
Steel	Self-Propelled I	FF Gen Cargo	$673.26	$501.49

BENEFIT ESTIMATION

Light-loading Cost Reduction Benefits through Channel Deepening

Transportation costs for 37 feet of channel depth (the without-project condition) and 40 feet of channel depth (the with-project condition) were estimated to compute the National Economic Development (NED) benefits associated with the project deepening. The difference between the without- and with-project transportation costs represents the benefits of the deepened channel. Cost efficiencies accrue because vessels are able to increase loading and reduce transits.

Total transportation costs are estimated using the specifications of each vessel (average deadweight, length overall, beam, design draft, speed, and so forth) along with estimated vessel transit characteristics, transit mileage, and vessel hourly operating cost data developed by the Corps' Institute for Water Resources (IWR).

The Manatee Harbor Port Authority vessel call data were used to determine which vessels would (i.e. currently) benefit from deepening the Federal channel. Vessels currently calling that benefit from a deeper channel at Manatee Harbor include bulk carriers transporting bulk fertilizer exports and bulk carriers transporting cement clinker and forest product imports. The analysis focused on these vessel classes and commodities.

The stated design draft of a vessel is related both to its rated deadweight and to the densest cargo the vessel is designed to carry. The vessel's deadweight assumes both a cargo tonnage level based on the vessel's lading capacity by weight and that the vessel contains 100 percent of its fuel, stores, water, and crew capacity, plus any ballast the vessel is expected to carry. Accordingly, the design draft refers to the maximum possible draft of the vessel.

In contrast, a vessel's *applied maximum transit draft* is a more accurate prediction of the vessel's deepest draft because it is based on a more likely level of non-cargo deadweight and a cargo weight equal to the vessel's applied lading capacity. Bunkerage (fuel) represents about 80 percent of non-cargo deadweight; stores, water, and crew requirements together represent about 20 percent. The portion of the vessel's fuel, stores, water, and crew weight remaining upon the vessel's arrival at Manatee Harbor is estimated to be two thirds of the full amount. The amount of ballast water expected to be carried is calculated according to the Corps' Institute for Water Resources (IWR) guidelines. Adding the adjusted non-cargo weight to the adjusted cargo weight gives the total transit weight of the fully loaded vessel.

The difference between the total transit weight and the deadweight divided by the immersion rate produces the expected deviation from the design draft in inches. Applying this deviation to the design draft yields the applied maximum transit draft of the vessel, which corresponds to the expected draft of the fully loaded vessel on a typical arrival to (for imported cargo) or departure from (for exported cargo) Manatee Harbor.

Three major trade routes for bulk fertilizer exports from Manatee Harbor include Japan/Australia/New Zealand (51 percent of tonnage), China (38 percent of tonnage), and South America (11 percent of tonnage). Three major trade routes for cement clinker imports to Manatee Harbor include Greece (49 percent of tonnage), South America (40 percent of tonnage), and Thailand (11 percent of tonnage). All forest product imports arrive from Brazil.

A critical factor in the analysis is to incorporate the 39-foot constraining depth in the Panama Canal for benefiting voyages that include a canal transit. The applied maximum transit depth, which is a function of the vessel and its trade route, is the greatest depth a vessel transiting Manatee Harbor could utilize given its maximum transit draft and the constraints it faces at Manatee Harbor or the Panama Canal. Vessel light-loading can be reduced by deepening at Manatee Harbor as long as the applied maximum transit depth is greater than the without-project depth. The point at which the channel depth equals the applied maximum transit depth is the point at which the channel depth fully accommodates the vessel's needs and no additional depth is beneficial for the vessel.

Yearly transportation savings by depth for the five vessel classes are summed together and discounted to the base year of the project using the current federal rate of 5.875 percent. The total of the discounted yearly transportation savings at a given depth represents the total base year benefit of the project at that depth. Using the Federal discount rate and the fifty-year life of the project to annualize the benefits produces the Average Annual Equivalent (AAEQ) benefits of the project at each depth. **Table A-7** presents the total discounted transportation savings that accrued following construction of Phase I in December 1996. **Table A-8** presents the total discounted transportation savings and the AAEQ benefits for each potential channel depth.

Table A-7
Light-loading Cost Reduction Benefits Pre Base Year 2005
(FY2003 Dollars discounted at 5 7/8% for Base Year 2005)

	Year	Benefits	Present Worth
	1997	$2,064,656	$3,168,096
	1998	$2,064,656	$2,992,298
	1999	$2,064,656	$2,826,256
	2000	$2,064,656	$2,669,427
	2001	$2,064,656	$2,521,301
	2002	$1,655,563	$1,909,542
	2003	$1,655,563	$1,803,582
	2004	$1,655,563	$1,703,501
Total			$19,594,002
Average Annual Equivalent			$1,221,490

Table A-8
Total Discounted and AAE Light-loading Cost Reduction Benefits for 38-40 Feet of Project Depth

	Channel Depth		
	38	39	40
Bulk Carriers Transporting Bulk Fertilizer Exports			
Self-Propelled II	$5,865,101	$10,914,726	$10,914,726
Self-Propelled III	$1,121,042	$2,170,847	$2,170,847
Total	$6,986,144	$13,085,574	$13,085,574
AAEQ	$435,516	$815,755	$815,755
Bulk Carriers Transporting Cement Clinker Imports			
Self-Propelled I	$4,060,145	$7,634,836	$9,493,093
Self-Propelled II	$2,720,550	$5,165,942	$6,460,861
Total	$6,780,695	$12,800,778	$15,953,954
AAEQ	$422,709	$798,001	$994,570
Bulk Carriers Transporting Forest Product Imports			
Self-Propelled III	$814,915	$1,544,474	$2,201,420
Total	$814,915	$1,544,474	$2,201,420
AAEQ	$50,802	$96,283	$137,237
Bulk Carriers Transporting Cement Imports			
Self-Propelled I	$922,751	$1,795,167	$1,837,581
Self-Propelled II	$1,071,896	$2,063,508	$2,110,746
Total	$1,994,648	$3,858,675	$3,948,327
AAEQ	$124,346	$240,550	$246,139
Bulk Carriers Transporting Limestone Imports			
Self-Propelled I	$138,845	$262,415	$383,917
Total	$138,845	$262,415	$383,917
AAEQ	$8,656	$16,359	$23,933
Bulk Carriers Transporting Bunker Fuel Imports			
Self-Propelled I	$13,432	$17,472	$17,472
Self-Propelled II	$4,997	$9,786	$14,381
Self-Propelled III	$14,379	$18,760	$18,760
Self-Propelled IV	$7,892	$10,312	$10,312
Total	$40,699	$56,331	$60,926
AAEQ	$2,537	$3,512	$3,798
Total For All Vessels			
Total	$16,755,945	$31,608,246	$35,634,119
AAEQ	$1,044,566	$1,970,458	$2,221,431

Delay Cost Reduction through Widener Construction and Turning Basin Expansion

The National Economic Development (NED) analysis of wideners and turning basins at Port Manatee uses the commodity forecasts, vessel characteristics, number of calls, and vessel and Port operating costs described previously to estimate transportation costs under with- and without-project conditions. The forecasts of these future conditions are used as inputs to a transportation cost model. The discounted cost savings of the alternative plans relative to the without-project condition throughout the period of analysis represent the benefits of the alternative channel wideners and turning basin combinations.

At the most basic level, the benefit estimation method is simply an assessment of the difference in transportation costs between the without-project condition and alternative with-project conditions. Typically, transportation cost savings are identified as a significant source of benefits through the use of larger and more efficient vessels in the calling fleet. In this analysis, however, the major source of benefits lies in the reduction of: (1) tidal delays as large vessels wait to enter the Port Manatee Channel and (2) transit times for vessels passing to/from the Channel entrance and berth.

A simulation model was developed to incorporate into the benefits analysis the following operational and cost parameters: frequency and pattern of vessel arrivals, tidal delays experienced, channel transit time, berth availability, vessel berth preferences, berth set-up and break-down time, and the likelihood of diversion.

The Port Manatee simulation model analyzes the costs of delays associated with large vessels waiting for slack tide at the entrance to the Port Manatee Channel and costs associated with time required to transit the channel from entrance to/from berth. The model also simulates vessel traffic congestion in terms of vessel delay, diversion, port, and stevedoring costs. Model runs were conducted for a 20-year period under with- and without-project conditions using the analytical inputs described above.

The model is an hour-by-hour simulation of port activity through the period of analysis. Model iterations are made in one-hour increments for each year of the forecast period, simulating vessel arrival and departures in each hour every year, for twenty years. Port operational constraints, fleet forecasts, and transportation costs developed as part of this analysis served as the primary inputs to the simulation model. In addition, commodity/vessel frequency distributions and vessel/commodity berthing preferences were developed as part of the model.

One of the primary assumptions of the model is that no more than one vessel will arrive in any given hour. Based on the fleet forecasts discussed above, 540 vessels are anticipated to call at Port Manatee in 2005 under with-project conditions. The probability that a vessel would call at Port Manatee during any hour throughout that year under with-project conditions was therefore set at 6.1644 percent (540 vessels /8760 hours per year). For each year of the simulation, the hourly probability of vessels arriving was calculated in a similar fashion, using calls anticipated for each individual year. Many of the vessels that call at Port Manatee can only utilize certain berths, and nearly all port tenants have a preferred berth. Discussions with Port tenants and Port personnel, as well as observations of actual port operations revealed operating restrictions and processing rules

Tampa Bay in the vicinity of Port Manatee has irregular tides with diurnal and semidiurnal characteristics. There can be two to four slack tides per day, and the slack tide can have a duration of two hours or five minutes. In general, the pilots attempt to transit the channel during slack tides to take advantage of low tidal current during peaks and troughs of the tidal cycle.

The intersection of the Tampa Bay channel and the Port Manatee channel is approximately a 90° degree angle. This sharp angle is difficult for large commercial vessels to negotiate. Winds and tidal currents, which run abeam of vessels entering/exiting the Port Manatee channel make conditions more challenging. To promote safe navigation at Port Manatee, the Tampa Pilots have adopted guidelines for entering/exiting the channel. These guidelines are based on vessel draft, since tidal currents are the principal navigational challenge at this location.

Representatives of the Tampa Pilots Association were queried about navigation in the Port Manatee Channel and in the harbor under with-project conditions. Specifically, they were asked how their navigation practices might change with the channel wideners and with the alternative turning basin configurations. The pilots were familiar with the widener design, and some of those interviewed had participated in the WES ship simulation as part of the design process. Regarding the necessity of slack tide transits, the pilots considered the improved channel access/egress provided by the wideners and concluded that the same operational rules as currently employed would apply to vessels drawing more than 34 feet, rather than 27 feet per current practice. Therefore, under with project conditions, vessels drawing between 27 and 34 feet would be able to operate in an unconstrained manner. Larger vessels, such as those drawing more than 30 feet, currently must make the turn very slowly. These vessels would experience some time savings while making the turn at the channel junction. This time savings is incorporated into the transit times estimated for the alternative plans.

In reviewing the turning basin alternatives, the pilots indicated that they would not affect Port operations for vessels smaller than 650 feet LOA. As noted previously, the pilots considered Alternative A-3 to be a marginal improvement over existing conditions. Dredging the tip of the shallow area adjacent to the current Berth 5 would be helpful to the pilots by allowing them to maintain a slightly higher speed down the channel with a consequent improvement in maneuverability in tidal cross-currents. With this alternative, they anticipated that they would continue to turn vessels larger than 650 feet LOA in three-point turns per current practice.

The pilots had the same perspective regarding Alternatives A-7 and A-4. Alternative A-7 would be a marginal improvement over Alternative A-3, and Alternative A-4 would be a marginal improvement over Alternative A-7. As for Alternative A-3, the pilots appreciated the higher speeds down the channel that would be possible with each alternative. However, they anticipated that they would continue to turn vessels larger than 650 feet LOA in three-point turns per current practice.

In considering the turning basin alternatives and the widening alternative, the pilots qualified their remarks as preliminary. Their operational responses to the navigation improvements would depend on the circumstances extant at that time. For example, the pilots left open the possibility of a rotational turn of larger vessels (i.e., > 650 feet LOA) in the turning basin with Alternatives A-3 and A-7. Alternative A-4 was noted as being more attractive than A-3 and A-7 for this maneuver.

The pilots considered Alternatives A-3 and A-7 to be equivalent in terms of time savings. They also considered Alternatives A-4 and A-6 to be equivalent, recognizing the increased margin for error in turning basin operations that would be afforded to the pilots by the larger plans of each equivalent pair. "Error" in this case refers to possible mistakes that could result in additional time-consuming maneuvers, rather than mistakes that could result in accidents or losses of any sort.

Recognizing the variety of parameters affecting ship and port operations at any given time, the pilots summarized the effects of the turning basin alternatives in terms of time saved for ship and tugs in the passage in/out between the channel entrance and berth. For vessels over 650 feet LOA, the transit time is typically 2 hours. According to the pilots, Alternatives A-3 and A-7 would likely reduce the transit time to 1.25 hours. For existing conditions and for Alternatives A-3 and A-7, if a ship is docked at Berth 6 or Berth 11, an additional 15 minutes would be required. According to the pilots, Alternatives A-4 and A-6 would reduce the transit to one hour, and the presence of a vessel at Berth 6 or Berth 11 would not increase the time required under Alternative A-4 or Alternative A-6.

The primary benefits expected to result from the alternative plans are the transportation cost savings resulting from reductions in: (1) delays for large vessels and assisting tugs entering the Port Manatee due to operational constraints posed by tidal currents and (2) transit time for large commercial vessels and assisting tugs from the Channel entrance to/from berth at Port Manatee. The transportation cost model calculates transportation costs associated with queuing delays, diversion of vessels to other ports, in-port vessel shifts, and other associated minor costs. Average annual delay cost reduction benefits are displayed, by alternative in **Table A-9**.

Through discussions with port tenants, port personnel and an examination of vessel call data, preferred berths were assigned to each vessel/commodity class. Most vessel/commodity types can dock at more than one berth throughout the port, while others can dock at only one berth. The simulation model computes the transportation costs for all vessels that are projected to call at Port Manatee over the 20-year projection period. Forecasts of vessel calls, costs, berthing preferences, berth setup and breakdown times, and the likelihood of diversion costs are all analyzed to determine transportation costs for both with- and without project alternatives.

Table A-9
Manatee Harbor Delay Cost Reduction Average Annual Benefits
(FY2003 Dollars discounted at 5 7/8% for Base Year 2005)

Alternative		**AAE Benefits**
Without Project		----
A-3	900' turning basin located tangent to south channel; wideners and deepening to 40'	$1,857,771
A-7	900'x1200' turning basin; wideners and deepening to 40'	$1,857,771
A-4	900'x1300' turning basin; wideners and deepening to 40'	$1,875,135
A-6	1200' turning basin located tangent to south channel; wideners and deepening to 40'	$1,875,135

SUMMARY OF PROJECT BENEFITS

Table A-10 displays total average annual benefits accruing from authorized improvements at Manatee Harbor. The benefits reflect FY2003 dollars discounted at 5 7/8 percent from a base year of 2005.

Table A-10
Manatee Harbor LRR Average Annual Project Benefits
(FY2003 dollars discounted at 5 7/8%)

	A-3	A-7	A-4	A-6
Light-loading Cost Reduction (Pre-2005)	$1,221,490	$1,221,490	$1,221,490	$1,221,490
Light-loading Cost Reduction through Deepening	$2,221,431	$2,221,431	$2,221,431	$2,221,431
Delay Cost Reduction through Widener and Turning Basin Construction	$1,857,771	$1,857,771	$1,875,135	$1,875,135
Total	$5,300,693	$5,300,693	$5,318,056	$5,318,056

SENSITIVITY ANALYSIS

A sensitivity analysis was performed estimating the benefits of the alternative plans including the modification of Berth 5 as planned by MCPA. The modification of Berth 5 would involve extension of the berth to a 1,200-foot marginal wharf with a 40-foot draft (currently 350 feet with 20-foot draft). This improvement would allow Vulcan Materials Company to relocate their operations to this berth and potentially bring in larger bulk vessels than currently used. **Table A-11** presents the results of a sensitivity analysis comparing the above without-project condition to revised with-project conditions. The annual benefits attributable to the Berth 5 expansion represent incremental (additional) benefits. The annual costs reflect the incremental costs associated with the construction of channel access to Berth 5.

Table A-11
Sensitivity Analyses-- Berth 5 Expansion
(FY 2003 Dollars discounted at 5 7/8% for Base Year 2005)

Alternative	AAE Benefits	AAE Costs	Net Benefits
A-3	$484,519	$139,547	$344,972
A-7	$484,519	$85,200	$399,319
A-4	$464,075	$62,944	$401,131
A-6	$469,125	$90,971	$378,154

Addendum I. Light-loading Cost Reduction
Appendix A. Economics

Benefits to Channel Deepening Accruing from Reduction in Light Loading

Transportation costs for 37 feet of channel depth (the without-project condition) and 40 feet of channel depth (the with-project condition) were estimated to compute the National Economic Development (NED) benefits associated with the project deepening. The difference between the without- and with-project transportation costs represents the benefits of the deepened channel. Cost efficiencies accrue because vessels are able to increase loading and reduce transits.

Total transportation costs are estimated using the specifications of each vessel (average deadweight, length overall, beam, design draft, speed, and so forth) along with estimated vessel transit characteristics, transit mileage, and vessel hourly operating cost data developed by the Corps' Institute for Water Resources (IWR), found in Economic Guidance Memorandum 02-06, Deep Draft Operating Costs, adjusted to 2003 price levels.

Vessels Potentially Benefiting from Channel Deepening

The Manatee Harbor Port Authority provided vessel call data for fiscal year 2002. These data were used to determine which vessels would benefit from deepening the Federal channel. Vessels currently calling that could benefit from a deeper channel at Manatee Harbor include bulk carriers transporting bulk fertilizer exports and bulk carriers transporting cement clinker and forest product imports. The analysis process is shown for these vessel classes. Additional benefiting vessels include bulk carriers transporting cement (a different commodity category from cement clinkers) and limestone imports and tankers transporting bunker fuel imports. These analyses were identical to those shown and their results are included in the final summary benefit tables.

Vessel Specifications and Applied Lading Capacities

The maximum lading capacity by volume of a vessel refers to the number of short tons of cargo the vessel will carry when its cubic capacity is full, given the stowage factor of the commodity carried. Unrelated to the lading capacity by volume, the vessel's maximum lading capacity by weight refers to the maximum number of tons of cargo it can hold regardless of whether its cargo area is volumetrically filled and equals the deadweight of the vessel less the weight of its non-cargo components.

For a vessel carrying a commodity of a lower density, the lading capacity by weight may exceed the actual capacity of the vessel. For a vessel carrying a commodity of a higher density, the lading capacity by volume may exceed the actual capacity of the vessel. The *applied lading capacity* of the vessel refers to its actual capacity given the density of the commodity it is carrying; applied lading capacity equals the lesser of the lading capacity by weight and the lading capacity by volume.

Table 1 shows the vessel specifications and applied lading capacities of the bulk carriers expected to benefit from channel deepening.

Table 1: Vessel Specifications of Benefiting Bulk Carrier Fleet at Manatee Harbor

	Bulk Fertilizer	
	Self-Propelled II	Self-Propelled III
Deadweight (Short Tons)	28,696	69,269
Length Between Perpendiculars	614	710
Extreme Breadth	92	104
Design Draft (Feet)	39	40
Speed (Knots per Hours)	14.8	14.6
Gross Cargo Capacity	90.7%	93.3%
Lading Capacity by Weight (Short Tons)	26,015	64,596
Cubic Capacity (Cubic Meters)	52,992	79,843
Lading Capacity by Volume	50,779	76,510
Applied Lading Capacity (Short Tons)	26,015	64,596
Bunkerage, Stores, Water, Crew (Short Tons)	1,787	3,115
Ballast (Short Tons)	215	520
Fully Loaded Transit Weight	28,018	68,230
Block Plane Coefficient	0.77	0.80
Water Plane Coefficient	0.85	0.87
Immersion Rate (Short Tons per Inch)	127.96	154.19
Deviation from Design Draft (feet)	0.4	0.6
Applied Maximum Transit Draft	38.6	39.4
Fully Loaded Transit Depth Requirement	41.6	42.4

	Cement Clinkers	
	Self-Propelled I	Self-Propelled II
Deadweight (Short Tons)	26,097	31,625
Length Between Perpendiculars	556	611
Extreme Breadth	87	90
Design Draft (Feet)	38	38
Speed (Knots per Hours)	14.6	14.8
Gross Cargo Capacity	90.7%	91.0%
Lading Capacity by Weight (Short Tons)	23,659	28,773
Cubic Capacity (Cubic Meters)	42,869	52,456
Lading Capacity by Volume	65,161	79,732
Applied Lading Capacity (Short Tons)	23,659	28,773
Bunkerage, Stores, Water, Crew (Short Tons)	1,625	1,901
Ballast (Short Tons)	196	237
Fully Loaded Transit Weight	25,480	30,911
Block Plane Coefficient	0.75	0.77
Water Plane Coefficient	0.83	0.84
Immersion Rate (Short Tons per Inch)	108.03	112.85
Deviation from Design Draft (feet)	0.5	0.5
Applied Maximum Transit Draft	37.5	37.5
Fully Loaded Transit Depth Requirement	40.5	40.5

	Forest Products
	Self-Propelled III
Deadweight (Short Tons)	32,744
Length Between Perpendiculars	562
Extreme Breadth	89
Design Draft (Feet)	39
Speed (Knots per Hours)	14.6
Gross Cargo Capacity	91.0%
Lading Capacity by Weight (Short Tons)	29,791
Cubic Capacity (Cubic Meters)	44,624
Lading Capacity by Volume	49,175
Applied Lading Capacity (Short Tons)	29,791
Bunkerage, Stores, Water, Crew (Short Tons)	1,969
Ballast (Short Tons)	246
Fully Loaded Transit Weight	32,006
Block Plane Coefficient	0.79
Water Plane Coefficient	0.86
Immersion Rate (Short Tons per Inch)	115.15
Deviation from Design Draft (feet)	0.5
Applied Maximum Transit Draft	38.5
Fully Loaded Transit Depth Requirement	41.5

Fully Loaded Transit Weight and Applied Maximum Transit Draft

The stated design draft of a vessel is related both to its rated deadweight and to the densest cargo the vessel is designed to carry. The vessel's deadweight assumes both a cargo tonnage level based on the vessel's lading capacity by weight and that the vessel contains 100 percent of its fuel, stores, water, and crew capacity, plus any ballast the vessel is expected to carry. Accordingly, the design draft refers to the maximum possible draft of the vessel.

In contrast, a vessel's *applied maximum transit draft* is a more accurate prediction of the vessel's deepest draft because it is based on a more likely level of non-cargo deadweight and a cargo weight equal to the vessel's applied lading capacity. Bunkerage (fuel) represents about 80 percent of non-cargo deadweight; stores, water, and crew requirements together represent about 20 percent. The portion of the vessel's fuel, stores, water, and crew weight remaining upon the vessel's arrival at Manatee Harbor is estimated to be two thirds of the full amount. The amount of ballast water expected to be carried is calculated according to the Corps' Institute for Water Resources (IWR) guidelines. Adding the adjusted non-cargo weight to the adjusted cargo weight gives the total transit weight of the fully loaded vessel.

As shown in **Table 1**, the fully loaded transit weights of the vessels are less than their deadweights, implying applied maximum transit drafts that are less than the vessels' design drafts. The immersion rate of a vessel equals the number of tons stowed per inch of draft. Immersion rates based on the block pane coefficient and the water plane coefficient of the vessel are developed using an equation provided for different vessel types by the Maritime Administration (MARAD) of the U.S. Department of Transportation. Key vessel characteristics (design draft, length between perpendiculars, maximum breadth, and service speed) are used to calculate the block plane coefficient and the water plane coefficient of each vessel.

The difference between the total transit weight and the deadweight divided by the immersion rate produces the expected deviation from the design draft in inches. Applying this deviation to the design draft yields the applied maximum transit draft of the vessel, which corresponds to the expected draft of the fully loaded vessel on a typical arrival to (for imported cargo) or departure from (for exported cargo) Manatee Harbor. **Table 1** shows the applied maximum transit drafts of the vessels expected to benefit from channel deepening.

Underkeel Clearance

Interviews with shippers and pilots at Manatee Harbor revealed that standard operating procedures at the harbor include an allowance of three feet for underkeel clearance.

Fully Loaded Transit Depth Requirement

The applied maximum transit draft of the vessel plus the appropriate underkeel allowance equals the fully loaded transit depth requirement of the vessel, which is shown for each bulk carrier vessel class in **Table 1**.

Vessel Trade Routes

Three major trade routes for bulk fertilizer exports from Manatee Harbor include Japan/Australia/New Zealand (51% of tonnage), China (38% of tonnage), and South America (11% of tonnage). Three major trade routes for cement clinker imports to Manatee Harbor include Greece (49% of tonnage), South America (40% of tonnage), and Thailand (11% of tonnage). All forest product imports arrive from Brazil.

Applicable Constraint, Applied Maximum Transit Depth, Actual Transit Draft, Lading in Short Tons, and Total Transit Weight of Vessel

A critical factor in the analysis is to incorporate the 39-foot constraining depth in the Panama Canal for benefiting voyages that include a canal transit. The applied maximum transit depth, which is a function of the vessel and its trade route, is the greatest depth a vessel transiting Manatee Harbor could utilize given its maximum transit draft and the constraints it faces at Manatee Harbor or the Panama Canal. Light loading by the vessel can be reduced by deepening at Manatee Harbor as long as the applied maximum transit depth is greater than the without-project depth. The point at which the channel depth equals the applied maximum transit depth is the point at which the channel depth fully accommodates the vessel's needs and no additional depth is beneficial for the vessel.

The actual transit draft of the vessel is the lesser of the channel depth and the maximum transit depth, less the three-foot underkeel allowance. The deviation of the actual transit draft from the maximum transit draft applied to the immersion factor gives the amount of light loading necessary to accommodate the actual transit depth. Subtracting the light loaded tonnage from the applied lading capacity results in the actual short tons carried by the arriving or departing vessel. This actual lading increases as the channel is deepened until light loading has been eliminated.

Adding the actual lading at each channel depth to the estimated short tons of crew, stores, water, bunkerage, and ballast carried by the transiting vessel (see **Table 1**) produces the expected total transit weight of the vessel at each channel depth.

Tables 2 through **6** show the canal constraint, the applied maximum transit depth, the actual transit draft by project depth, lading in short tons by project depth, and the total transit weight of the vessel by project depth of each vessel class for each trade route for the outbound (fertilizer exports) and inbound (cement clinker and forest product export) transits at Manatee Harbor.

Table 2: Canal Restraint, Applied Maximum Transit Depth, Actual Transit Draft, Lading in Short Tons, and Total Transit Weight in Short Tons for Outbound SP II Bulk Carriers Transporting Bulk Fertilizer from Manatee Harbor

	Self-Propelled II - South America Trade Region	Self-Propelled II - Japan/Australia/New Zealand Trade Region	Self-Propelled II - China Trade Region
Channel or Canal Restraint	Panama	Panama	Panama
Channel Constraint at Port of Origin or Canal Restraint (Feet)	39.0	39.0	39.0
Actual Transit Draft at 37 Feet	34.0	34.0	34.0
Actual Transit Draft at 38 Feet	35.0	35.0	35.0
Actual Transit Draft at 39 Feet	36.0	36.0	36.0
Actual Transit Draft at 40 Feet	36.0	36.0	36.0
Actual Transit Draft at 41 Feet	36.0	36.0	36.0
Actual Transit Draft at 42 Feet	36.0	36.0	36.0
Actual Transit Draft at 43 Feet	36.0	36.0	36.0
Actual Transit Draft at 44 Feet	36.0	36.0	36.0
Actual Transit Draft at 45 Feet	36.0	36.0	36.0
Lading at 37 Feet	19,016	19,016	19,016
Lading at 38 Feet	20,552	20,552	20,552
Lading at 39 Feet	22,087	22,087	22,087
Lading at 40 Feet	22,087	22,087	22,087
Lading at 41 Feet	22,087	22,087	22,087
Lading at 42 Feet	22,087	22,087	22,087
Lading at 43 Feet	22,087	22,087	22,087
Lading at 44 Feet	22,087	22,087	22,087
Lading at 45 Feet	22,087	22,087	22,087
Total Transit Weight - 37 Feet	21,019	21,019	21,019
Total Transit Weight - 38 Feet	22,554	22,554	22,554
Total Transit Weight - 39 Feet	24,090	24,090	24,090
Total Transit Weight - 40 Feet	24,090	24,090	24,090
Total Transit Weight - 41 Feet	24,090	24,090	24,090
Total Transit Weight - 42 Feet	24,090	24,090	24,090
Total Transit Weight - 43 Feet	24,090	24,090	24,090
Total Transit Weight - 44 Feet	24,090	24,090	24,090
Total Transit Weight - 45 Feet	24,090	24,090	24,090

Table 3: Canal Restraint, Applied Maximum Transit Depth, Actual Transit Draft, Lading in Short Tons, and Total Transit Weight in Short Tons for Outbound SP III Bulk Carriers Transporting Bulk Fertilizer from Manatee Harbor

	Self-Propelled III - South America Trade Region	Self-Propelled III - Japan/Australia/New Zealand Trade Region	Self-Propelled III - China Trade Region
Channel or Canal Restraint	Panama	Panama	Panama
Channel Constraint at Port of Origin or Canal Restraint (Feet)	39.0	39.0	39.0
Actual Transit Draft at 37 Feet	34.0	34.0	34.0
Actual Transit Draft at 38 Feet	35.0	35.0	35.0
Actual Transit Draft at 39 Feet	36.0	36.0	36.0
Actual Transit Draft at 40 Feet	36.0	36.0	36.0
Actual Transit Draft at 41 Feet	36.0	36.0	36.0
Actual Transit Draft at 42 Feet	36.0	36.0	36.0
Actual Transit Draft at 43 Feet	36.0	36.0	36.0
Actual Transit Draft at 44 Feet	36.0	36.0	36.0
Actual Transit Draft at 45 Feet	36.0	36.0	36.0
Lading at 37 Feet	54,532	54,532	54,532
Lading at 38 Feet	56,383	56,383	56,383
Lading at 39 Feet	58,233	58,233	58,233
Lading at 40 Feet	58,233	58,233	58,233
Lading at 41 Feet	58,233	58,233	58,233
Lading at 42 Feet	58,233	58,233	58,233
Lading at 43 Feet	58,233	58,233	58,233
Lading at 44 Feet	58,233	58,233	58,233
Lading at 45 Feet	58,233	58,233	58,233
Total Transit Weight - 37 Feet	58,167	58,167	58,167
Total Transit Weight - 38 Feet	60,017	60,017	60,017
Total Transit Weight - 39 Feet	61,868	61,868	61,868
Total Transit Weight - 40 Feet	61,868	61,868	61,868
Total Transit Weight - 41 Feet	61,868	61,868	61,868
Total Transit Weight - 42 Feet	61,868	61,868	61,868
Total Transit Weight - 43 Feet	61,868	61,868	61,868
Total Transit Weight - 44 Feet	61,868	61,868	61,868
Total Transit Weight - 45 Feet	61,868	61,868	61,868

Table 4: Canal Restraint, Applied Maximum Transit Depth, Actual Transit Draft, Lading in Short Tons, and Total Transit Weight in Short Tons for Inbound SP I Bulk Carriers Transporting Cement Clinkers to Manatee Harbor

	Self-Propelled I - South America Trade Region	Self-Propelled I - Greece Trade Region	Self-Propelled I - Thailand Trade Region
Channel or Canal Restraint	none	none	Panama Canal
Channel Constraint at Port of Origin or Canal Restraint (Feet)	40.0	40.0	39.0
Actual Transit Draft at 37 Feet	34.0	34.0	34.0
Actual Transit Draft at 38 Feet	35.0	35.0	35.0
Actual Transit Draft at 39 Feet	36.0	36.0	36.0
Actual Transit Draft at 40 Feet	37.0	37.0	36.0
Actual Transit Draft at 41 Feet	37.0	37.0	36.0
Actual Transit Draft at 42 Feet	37.0	37.0	36.0
Actual Transit Draft at 43 Feet	37.0	37.0	36.0
Actual Transit Draft at 44 Feet	37.0	37.0	36.0
Actual Transit Draft at 45 Feet	37.0	37.0	36.0
Lading at 37 Feet	19,091	19,091	19,091
Lading at 38 Feet	20,387	20,387	20,387
Lading at 39 Feet	21,684	21,684	21,684
Lading at 40 Feet	22,980	22,980	21,684
Lading at 41 Feet	22,980	22,980	21,684
Lading at 42 Feet	22,980	22,980	21,684
Lading at 43 Feet	22,980	22,980	21,684
Lading at 44 Feet	22,980	22,980	21,684
Lading at 45 Feet	22,980	22,980	21,684
Total Transit Weight - 37 Feet	20,912	20,912	20,912
Total Transit Weight - 38 Feet	22,209	22,209	22,209
Total Transit Weight - 39 Feet	23,505	23,505	23,505
Total Transit Weight - 40 Feet	24,801	24,801	23,505
Total Transit Weight - 41 Feet	24,801	24,801	23,505
Total Transit Weight - 42 Feet	24,801	24,801	23,505
Total Transit Weight - 43 Feet	24,801	24,801	23,505
Total Transit Weight - 44 Feet	24,801	24,801	23,505
Total Transit Weight - 45 Feet	24,801	24,801	23,505

Table 5: Canal Restraint, Applied Maximum Transit Depth, Actual Transit Draft, Lading in Short Tons, and Total Transit Weight in Short Tons for Inbound SP II Bulk Carriers Transporting Cement Clinkers to Manatee Harbor

	Self-Propelled II - South America Trade Region	Self-Propelled II - Greece Trade Region	Self-Propelled II - Thailand Trade Region
Channel or Canal Restraint	none	none	Panama Canal
Channel Constraint at Port of Origin or Canal Restraint (Feet)	40.0	40.0	39.0
Actual Transit Draft at 37 Feet	34.0	34.0	34.0
Actual Transit Draft at 38 Feet	35.0	35.0	35.0
Actual Transit Draft at 39 Feet	36.0	36.0	36.0
Actual Transit Draft at 40 Feet	37.0	37.0	36.0
Actual Transit Draft at 41 Feet	37.0	37.0	36.0
Actual Transit Draft at 42 Feet	37.0	37.0	36.0
Actual Transit Draft at 43 Feet	37.0	37.0	36.0
Actual Transit Draft at 44 Feet	37.0	37.0	36.0
Actual Transit Draft at 45 Feet	37.0	37.0	36.0
Lading at 37 Feet	24,070	24,070	24,070
Lading at 38 Feet	25,424	25,424	25,424
Lading at 39 Feet	26,778	26,778	26,778
Lading at 40 Feet	28,132	28,132	26,778
Lading at 41 Feet	28,132	28,132	26,778
Lading at 42 Feet	28,132	28,132	26,778
Lading at 43 Feet	28,132	28,132	26,778
Lading at 44 Feet	28,132	28,132	26,778
Lading at 45 Feet	28,132	28,132	26,778
Total Transit Weight - 37 Feet	26,208	26,208	26,208
Total Transit Weight - 38 Feet	27,562	27,562	27,562
Total Transit Weight - 39 Feet	28,917	28,917	28,917
Total Transit Weight - 40 Feet	30,271	30,271	28,917
Total Transit Weight - 41 Feet	30,271	30,271	28,917
Total Transit Weight - 42 Feet	30,271	30,271	28,917
Total Transit Weight - 43 Feet	30,271	30,271	28,917
Total Transit Weight - 44 Feet	30,271	30,271	28,917
Total Transit Weight - 45 Feet	30,271	30,271	28,917

Table 6: Canal Restraint, Applied Maximum Transit Depth, Actual Transit Draft, Lading in Short Tons, and Total Transit Weight in Short Tons for Inbound SP III Bulk Carriers Transporting Forest Products to Manatee Harbor

	Self-Propelled III - Brazil Trade Region
Channel or Canal Restraint	none
Channel Constraint at Port of Origin or Canal Restraint (Feet)	40.0
Actual Transit Draft at 37 Feet	34.0
Actual Transit Draft at 38 Feet	35.0
Actual Transit Draft at 39 Feet	36.0
Actual Transit Draft at 40 Feet	37.0
Actual Transit Draft at 41 Feet	37.0
Actual Transit Draft at 42 Feet	37.0
Actual Transit Draft at 43 Feet	37.0
Actual Transit Draft at 44 Feet	37.0
Actual Transit Draft at 45 Feet	37.0
Lading at 37 Feet	23,621
Lading at 38 Feet	25,003
Lading at 39 Feet	26,385
Lading at 40 Feet	27,767
Lading at 41 Feet	27,767
Lading at 42 Feet	27,767
Lading at 43 Feet	27,767
Lading at 44 Feet	27,767
Lading at 45 Feet	27,767
Total Transit Weight - 37 Feet	25,835
Total Transit Weight - 38 Feet	27,217
Total Transit Weight - 39 Feet	28,599
Total Transit Weight - 40 Feet	29,981
Total Transit Weight - 41 Feet	29,981
Total Transit Weight - 42 Feet	29,981
Total Transit Weight - 43 Feet	29,981
Total Transit Weight - 44 Feet	29,981
Total Transit Weight - 45 Feet	29,981

Tonnage Transported for the Life of the Project

Tables 7 through **9** display the predicted tonnage level for each commodity itemized by trade route.

Table 7: Actual and Predicted Tonnage for Bulk Fertilizer Exports Carried on Benefiting Bulk Carriers by Trade Route

	South America		
	Imports	**Exports**	**Total**
	Actual Tonnage	*Actual Tonnage*	*Actual Tonnage*
2002	0	55,425	55,425
Project Year Range	*Predicted Tonnage*	*Predicted Tonnage*	*Predicted Tonnage*
Years 1 - 5	0	88,184	88,184
Years 6 - 10	0	92,196	92,196
Years 11 - 15	0	92,196	92,196
Years 16 - 20	0	92,196	92,196
Years 21 - 25	0	92,196	92,196
Years 26 - 30	0	92,196	92,196
Years 31 - 35	0	92,196	92,196
Years 36 - 40	0	92,196	92,196
Years 41 - 45	0	92,196	92,196
Years 46 - 50	0	92,196	92,196
	Japan/Australia/New Zealand		
	Imports	**Exports**	**Total**
	Actual Tonnage	*Actual Tonnage*	*Actual Tonnage*
2002	0	254,043	254,043
Project Year Range	*Predicted Tonnage*	*Predicted Tonnage*	*Predicted Tonnage*
Years 1 - 5	0	404,195	404,195
Years 6 - 10	0	422,582	422,582
Years 11 - 15	0	422,582	422,582
Years 16 - 20	0	422,582	422,582
Years 21 - 25	0	422,582	422,582
Years 26 - 30	0	422,582	422,582
Years 31 - 35	0	422,582	422,582
Years 36 - 40	0	422,582	422,582
Years 41 - 45	0	422,582	422,582
Years 46 - 50	0	422,582	422,582
	China		
	Imports	**Exports**	**Total**
	Actual Tonnage	*Actual Tonnage*	*Actual Tonnage*
2002	0	185,823	185,823
Project Year Range	*Predicted Tonnage*	*Predicted Tonnage*	*Predicted Tonnage*
Years 1 - 5	0	295,654	295,654
Years 6 - 10	0	309,103	309,103
Years 11 - 15	0	309,103	309,103
Years 16 - 20	0	309,103	309,103
Years 21 - 25	0	309,103	309,103
Years 26 - 30	0	309,103	309,103
Years 31 - 35	0	309,103	309,103
Years 36 - 40	0	309,103	309,103
Years 41 - 45	0	309,103	309,103
Years 46 - 50	0	309,103	309,103
	All Trade Routes		
	Imports	**Exports**	**Total**
	Actual Tonnage	*Actual Tonnage*	*Actual Tonnage*
2002	0	495,291	495,291
Project Year Range	*Predicted Tonnage*	*Predicted Tonnage*	*Predicted Tonnage*
Years 1 - 5	0	788,033	788,033
Years 6 - 10	0	823,881	823,881
Years 11 - 15	0	823,881	823,881
Years 16 - 20	0	823,881	823,881
Years 21 - 25	0	823,881	823,881
Years 26 - 30	0	823,881	823,881
Years 31 - 35	0	823,881	823,881
Years 36 - 40	0	823,881	823,881
Years 41 - 45	0	823,881	823,881
Years 46 - 50	0	823,881	823,881

Table 8: Actual and Predicted Tonnage for Cement Clinker Imports Carried on Benefiting Bulk Carriers by Trade Route

	South America		
	Imports	**Exports**	**Total**
	Actual Tonnage	*Actual Tonnage*	*Actual Tonnage*
2002	154,658	0	154,658
Project Year Range	*Predicted Tonnage*	*Predicted Tonnage*	*Predicted Tonnage*
Years 1 - 5	173,334	0	173,334
Years 6 - 10	187,726	0	187,726
Years 11 - 15	203,232	0	203,232
Years 16 - 20	220,020	0	220,020
Years 21 - 25	226,946	0	226,946
Years 26 - 30	226,946	0	226,946
Years 31 - 35	226,946	0	226,946
Years 36 - 40	226,946	0	226,946
Years 41 - 45	226,946	0	226,946
Years 46 - 50	226,946	0	226,946
	Greece		
	Imports	**Exports**	**Total**
	Actual Tonnage	*Actual Tonnage*	*Actual Tonnage*
2002	190,783	0	190,783
Project Year Range	*Predicted Tonnage*	*Predicted Tonnage*	*Predicted Tonnage*
Years 1 - 5	213,822	0	213,822
Years 6 - 10	231,576	0	231,576
Years 11 - 15	250,704	0	250,704
Years 16 - 20	271,413	0	271,413
Years 21 - 25	279,957	0	279,957
Years 26 - 30	279,957	0	279,957
Years 31 - 35	279,957	0	279,957
Years 36 - 40	279,957	0	279,957
Years 41 - 45	279,957	0	279,957
Years 46 - 50	279,957	0	279,957
	Thailand		
	Imports	**Exports**	**Total**
	Actual Tonnage	*Actual Tonnage*	*Actual Tonnage*
2002	44,604	0	44,604
Project Year Range	*Predicted Tonnage*	*Predicted Tonnage*	*Predicted Tonnage*
Years 1 - 5	49,990	0	49,990
Years 6 - 10	54,140	0	54,140
Years 11 - 15	58,613	0	58,613
Years 16 - 20	63,454	0	63,454
Years 21 - 25	65,452	0	65,452
Years 26 - 30	65,452	0	65,452
Years 31 - 35	65,452	0	65,452
Years 36 - 40	65,452	0	65,452
Years 41 - 45	65,452	0	65,452
Years 46 - 50	65,452	0	65,452
	All Trade Routes		
	Imports	**Exports**	**Total**
	Actual Tonnage	*Actual Tonnage*	*Actual Tonnage*
2002	390,045	0	390,045
Project Year Range	*Predicted Tonnage*	*Predicted Tonnage*	*Predicted Tonnage*
Years 1 - 5	437,145	0	437,145
Years 6 - 10	473,442	0	473,442
Years 11 - 15	512,549	0	512,549
Years 16 - 20	554,886	0	554,886
Years 21 - 25	572,354	0	572,354
Years 26 - 30	572,354	0	572,354
Years 31 - 35	572,354	0	572,354
Years 36 - 40	572,354	0	572,354
Years 41 - 45	572,354	0	572,354
Years 46 - 50	572,354	0	572,354

Table 9: Actual and Predicted Tonnage for Forest Product Imports Carried on Benefiting Bulk Carriers by Trade Route

	Brazil		
	Imports	**Exports**	**Total**
	Actual Tonnage	*Actual Tonnage*	*Actual Tonnage*
2002	216,185	0	216,185
Project Year Range	*Predicted Tonnage*	*Predicted Tonnage*	*Predicted Tonnage*
Years 1 - 5	111,231	0	111,231
Years 6 - 10	143,182	0	143,182
Years 11 - 15	183,611	0	183,611
Years 16 - 20	235,457	0	235,457
Years 21 - 25	258,199	0	258,199
Years 26 - 30	258,199	0	258,199
Years 31 - 35	258,199	0	258,199
Years 36 - 40	258,199	0	258,199
Years 41 - 45	258,199	0	258,199
Years 46 - 50	258,199	0	258,199

Hourly Operating Costs, Trip Distance, and Total Voyage Cost

Hourly operating costs are based on standard at-sea vessel operating costs for each vessel type and class. The standard costs are found in an economic guidance memorandum published and updated annually by IWR.

Trip distances are calculated for the applicable outbound (bulk fertilizer exports) and inbound (cement clinker and forest product imports) voyages for each itinerary. In some cases, a full round trip is dedicated to transporting the cargo. Weighted average distances for each actual transit are used to determine a typical distance for each trade route.

Distances, vessel speeds, and vessel hourly operating costs at sea are used to determine the total voyage costs for the inbound and outbound voyages. **Tables 10** through **12** display the trip distances and total voyage costs for each vessel class's inbound or outbound transit.

Table 10: Trip Distances and Total Voyage Costs for Outbound Bulk Carriers Transporting Bulk Fertilizer Exports from Manatee Harbor

	Outbound Self-Propelled II	**Outbound Self-Propelled III**
Applicable trip distance - South America	636	636
Applicable trip distance - Japan/Australia/New Zealand	6,748	6,748
Applicable trip distance - China	10,448	10,448
Speed (Knots per Hour)	14.8	14.6
Vessel Operating Cost at Sea	$596	$736
Transit Cost - South America	$25,678	$32,044
Transit Cost - Japan/Australia/New Zealand	$272,573	$340,152
Transit Cost - China	$422,019	$526,651

Table 11: Trip Distances and Total Voyage Costs for Inbound Bulk Carriers Transporting Cement Clinker Imports to Manatee Harbor

	Inbound Self-Propelled I	Inbound Self-Propelled II
Applicable trip distance - South America	4,214	4,214
Applicable trip distance - Greece	5,237	5,237
Applicable trip distance - Thailand	26,154	26,154
Speed (Knots per Hour)	14.6	14.8
Vessel Operating Cost at Sea	$596	$610
Transit Cost - South America	$171,768	$173,227
Transit Cost - Greece	$213,473	$215,287
Transit Cost - Thailand	$1,066,102	$1,075,158

Table 12: Trip Distances and Total Voyage Costs for Inbound Bulk Carriers Transporting Forest Product Imports to Manatee Harbor

	Inbound Self-Propelled III
Applicable trip distance - Brazil	2,840
Speed (Knots per Hour)	14.6
Vessel Operating Cost at Sea	$593
Transit Cost - Brazil	$115,286

Cost per Capacity Ton

The voyage cost of the vessel divided by the tons carried equals the cost per ton of shipping the cargo. With-project cost per capacity ton decreases with each incremental depth as the capacity of the vessel increases, because the voyage cost is fixed. Shown in **Tables 13** through **17** are the costs per capacity ton and the savings per ton transported for the 37-foot (without-project), 38-foot, 39-foot, and 40-foot (with-project) depths, for each of the vessel class's inbound or outbound journey.

Table 13: Cost per Short Ton and Savings per Short Ton by Channel Depth and Itinerary for Outbound SP II Bulk Carriers Transporting Bulk Fertilizer Exports from Manatee Harbor

Channel Depth	Total Capacity of Vessel - South America Trade Region (Short Tons)	Total Capacity of Vessel - Japan/Australia/New Zealand Trade Region (Short Tons)	Total Capacity of Vessel - China Trade Region (Short Tons)
37	19,016	19,016	19,016
38	20,552	20,552	20,552
39	22,087	22,087	22,087
40	22,087	22,087	22,087
Channel Depth	**Total Cost per Capacity Ton - South America**	**Total Cost per Capacity Ton - Japan/Australia/New Zealand**	**Total Cost per Capacity Ton - China**
37	$1.35	$14.33	$22.19
38	$1.25	$13.26	$20.53
39	$1.16	$12.34	$19.11
40	$1.16	$12.34	$19.11
Channel Depth	**Savings per Capacity Ton - South America**	**Savings per Capacity Ton - Japan/Australia/New Zealand**	**Savings per Capacity Ton - China**
38	$0.10	$1.07	$1.66
39	$0.19	$1.99	$3.09
40	$0.19	$1.99	$3.09

Table 14: Cost per Short Ton and Savings per Short Ton by Channel Depth and Itinerary for Outbound SP III Bulk Carriers Transporting Bulk Fertilizer Exports from Manatee Harbor

Channel Depth	Total Capacity of Vessel - South America Trade Region (Short Tons)	Total Capacity of Vessel - Japan/Australia/New Zealand Trade Region (Short Tons)	Total Capacity of Vessel - China Trade Region (Short Tons)
37	54,532	54,532	54,532
38	56,383	56,383	56,383
39	58,233	58,233	58,233
40	58,233	58,233	58,233
Channel Depth	**Total Cost per Capacity Ton - South America**	**Total Cost per Capacity Ton - Japan/Australia/New Zealand**	**Total Cost per Capacity Ton - China**
37	$0.59	$6.24	$9.66
38	$0.57	$6.03	$9.34
39	$0.55	$5.84	$9.04
40	$0.55	$5.84	$9.04
Channel Depth	**Savings per Capacity Ton - South America**	**Savings per Capacity Ton - Japan/Australia/New Zealand**	**Savings per Capacity Ton - China**
38	$0.02	$0.20	$0.32
39	$0.04	$0.40	$0.61
40	$0.04	$0.40	$0.61

Table 15: Cost per Short Ton and Savings per Short Ton by Channel Depth and Itinerary for Inbound SP I Bulk Carriers Transporting Cement Clinker Imports to Manatee Harbor

Channel Depth	Total Capacity of Vessel - South America Trade Region (Short Tons)	Total Capacity of Vessel - Greece Trade Region (Short Tons)	Total Capacity of Vessel - Thailand Trade Region (Short Tons)
37	19,091	19,091	19,091
38	20,387	20,387	20,387
39	21,684	21,684	21,684
40	22,980	22,980	21,684
Channel Depth	**Total Cost per Capacity Ton - South America**	**Total Cost per Capacity Ton - Greece**	**Total Cost per Capacity Ton - Thailand**
37	$9.00	$11.18	$55.84
38	$8.43	$10.47	$52.29
39	$7.92	$9.84	$49.17
40	$7.47	$9.29	$49.17
Channel Depth	**Savings per Capacity Ton - South America**	**Savings per Capacity Ton - Greece**	**Savings per Capacity Ton - Thailand**
38	$0.57	$0.71	$3.55
39	$1.08	$1.34	$6.68
40	$1.52	$1.89	$6.68

Table 16: Cost per Short Ton and Savings per Short Ton by Channel Depth and Itinerary for Inbound SP II Bulk Carriers Transporting Cement Clinker Imports to Manatee Harbor

Channel Depth	Total Capacity of Vessel - South America Trade Region (Short Tons)	Total Capacity of Vessel - Greece Trade Region (Short Tons)	Total Capacity of Vessel - Thailand Trade Region (Short Tons)
37	24,070	24,070	24,070
38	25,424	25,424	25,424
39	26,778	26,778	26,778
40	28,132	28,132	26,778
Channel Depth	**Total Cost per Capacity Ton - South America**	**Total Cost per Capacity Ton - Greece**	**Total Cost per Capacity Ton - Thailand**
37	$7.20	$8.94	$44.67
38	$6.81	$8.47	$42.29
39	$6.47	$8.04	$40.15
40	$6.16	$7.65	$40.15
Channel Depth	**Savings per Capacity Ton - South America**	**Savings per Capacity Ton - Greece**	**Savings per Capacity Ton - Thailand**
38	$0.38	$0.48	$2.38
39	$0.73	$0.90	$4.52
40	$1.04	$1.29	$4.52

Table 17: Cost per Short Ton and Savings per Short Ton by Channel Depth and Itinerary for Inbound SP III Bulk Carriers Transporting Forest Product Imports to Manatee Harbor

Channel Depth	Total Capacity of Vessel - Brazil Trade Region (Short Tons)
37	23,621
38	25,003
39	26,385
40	27,767
Channel Depth	**Total Cost per Capacity Ton - Brazil**
37	$4.88
38	$4.61
39	$4.37
40	$4.15
Channel Depth	**Savings per Capacity Ton - Brazil**
37	
38	$0.27
39	$0.51
40	$0.73

Discounted Transportation and Average Annual Equivalent Cost Savings (Benefits) at Each Depth

Tables 18 to **22** display the process of using the cost per ton savings calculated for each vessel's applicable outbound or inbound transit for each trade route to find the total savings by year of the project at 38, 39, and 40 feet of channel depth.

Table 18: Savings Accruing to Outbound SP II Bulk Carriers Transporting Bulk Fertilizer Exports from Manatee Harbor by Channel Depth, Trade Region, and Project Year

Self-Propelled II Savings Resulting from 38 Foot Project by Trade Region and Project Year

Project Year	Self-Propelled II Tonnage per Year -South America	Savings per Year Transporting Manatee Harbor Bulk Fertilizer Tonnage - South America	Self-Propelled II Tonnage per Year - Japan/Australia/ New Zealand	Savings per Year Transporting Manatee Harbor Bulk Fertilizer Tonnage - Japan/Australia/ New Zealand	Self-Propelled II Tonnage per Year - China	Savings per Year Transporting Manatee Harbor Bulk Fertilizer Tonnage - China	Total Savings per Year on Self-Propelled II Vessels
Years 1 - 5	32,533	$3,282	149,116	$159,690	109,073	$180,850	$343,822
Years 6 - 10	34,013	$3,431	155,900	$166,954	114,035	$189,077	$359,462
Years 11 - 15	34,013	$3,431	155,900	$166,954	114,035	$189,077	$359,462
Years 16 - 20	34,013	$3,431	155,900	$166,954	114,035	$189,077	$359,462
Years 21 - 25	34,013	$3,431	155,900	$166,954	114,035	$189,077	$359,462
Years 26 - 30	34,013	$3,431	155,900	$166,954	114,035	$189,077	$359,462
Years 31 - 35	34,013	$3,431	155,900	$166,954	114,035	$189,077	$359,462
Years 36 - 40	34,013	$3,431	155,900	$166,954	114,035	$189,077	$359,462
Years 41 - 45	34,013	$3,431	155,900	$166,954	114,035	$189,077	$359,462
Years 46 - 50	34,013	$3,431	155,900	$166,954	114,035	$189,077	$359,462

Self-Propelled II Savings Resulting from 39 Foot Project by Trade Region and Project Year

Project Year	Self-Propelled II Tonnage per Year -South America	Savings per Year Transporting Manatee Harbor Bulk Fertilizer Tonnage - South America	Self-Propelled II Tonnage per Year - Japan/Australia/ New Zealand	Savings per Year Transporting Manatee Harbor Bulk Fertilizer Tonnage - Japan/Australia/	Self-Propelled II Tonnage per Year - China	Savings per Year Transporting Manatee Harbor Bulk Fertilizer Tonnage - China	Total Savings per Year on Self-Propelled II Vessels
Years 1 - 5	32,533	$6,108	149,116	$297,176	109,073	$336,555	$639,839
Years 6 - 10	34,013	$6,386	155,900	$310,695	114,035	$351,865	$668,946
Years 11 - 15	34,013	$6,386	155,900	$310,695	114,035	$351,865	$668,946
Years 16 - 20	34,013	$6,386	155,900	$310,695	114,035	$351,865	$668,946
Years 21 - 25	34,013	$6,386	155,900	$310,695	114,035	$351,865	$668,946
Years 26 - 30	34,013	$6,386	155,900	$310,695	114,035	$351,865	$668,946
Years 31 - 35	34,013	$6,386	155,900	$310,695	114,035	$351,865	$668,946
Years 36 - 40	34,013	$6,386	155,900	$310,695	114,035	$351,865	$668,946
Years 41 - 45	34,013	$6,386	155,900	$310,695	114,035	$351,865	$668,946
Years 46 - 50	34,013	$6,386	155,900	$310,695	114,035	$351,865	$668,946

Self-Propelled II Savings Resulting from 40 Foot Project by Trade Region and Project Year

Project Year	Self-Propelled II Tonnage per Year -South America	Savings per Year Transporting Manatee Harbor Bulk Fertilizer Tonnage - South America	Self-Propelled II Tonnage per Year - Japan/Australia/ New Zealand	Savings per Year Transporting Manatee Harbor Bulk Fertilizer Tonnage - Japan/Australia/	Self-Propelled II Tonnage per Year - China	Savings per Year Transporting Manatee Harbor Bulk Fertilizer Tonnage - China	Total Savings per Year on Self-Propelled II Vessels
Years 1 - 5	32,533	$6,108	149,116	$297,176	109,073	$336,555	$639,839
Years 6 - 10	34,013	$6,386	155,900	$310,695	114,035	$351,865	$668,946
Years 11 - 15	34,013	$6,386	155,900	$310,695	114,035	$351,865	$668,946
Years 16 - 20	34,013	$6,386	155,900	$310,695	114,035	$351,865	$668,946
Years 21 - 25	34,013	$6,386	155,900	$310,695	114,035	$351,865	$668,946
Years 26 - 30	34,013	$6,386	155,900	$310,695	114,035	$351,865	$668,946
Years 31 - 35	34,013	$6,386	155,900	$310,695	114,035	$351,865	$668,946
Years 36 - 40	34,013	$6,386	155,900	$310,695	114,035	$351,865	$668,946
Years 41 - 45	34,013	$6,386	155,900	$310,695	114,035	$351,865	$668,946
Years 46 - 50	34,013	$6,386	155,900	$310,695	114,035	$351,865	$668,946

Table 19: Savings Accruing to Outbound SP III Bulk Carriers Transporting Bulk Fertilizer Exports from Manatee Harbor by Channel Depth, Trade Region, and Project Year

Self-Propelled II Savings Resulting from 38 Foot Project by Trade Region and Project Year

Project Year	Self-Propelled II Tonnage per Year -South America	Savings per Year Transporting Manatee Harbor Bulk Fertilizer Tonnage - South America	Self-Propelled II Tonnage per Year - Japan/Australia/ New Zealand	Savings per Year Transporting Manatee Harbor Bulk Fertilizer Tonnage - Japan/Australia/ New Zealand	Self-Propelled II Tonnage per Year - China	Savings per Year Transporting Manatee Harbor Bulk Fertilizer Tonnage - China	Total Savings per Year on Self-Propelled II Vessels
Years 1 - 5	32,533	$627	149,116	$30,523	109,073	$34,567	$65,717
Years 6 - 10	34,013	$656	155,900	$31,911	114,035	$36,140	$68,707
Years 11 - 15	34,013	$656	155,900	$31,911	114,035	$36,140	$68,707
Years 16 - 20	34,013	$656	155,900	$31,911	114,035	$36,140	$68,707
Years 21 - 25	34,013	$656	155,900	$31,911	114,035	$36,140	$68,707
Years 26 - 30	34,013	$656	155,900	$31,911	114,035	$36,140	$68,707
Years 31 - 35	34,013	$656	155,900	$31,911	114,035	$36,140	$68,707
Years 36 - 40	34,013	$656	155,900	$31,911	114,035	$36,140	$68,707
Years 41 - 45	34,013	$656	155,900	$31,911	114,035	$36,140	$68,707
Years 46 - 50	34,013	$656	155,900	$31,911	114,035	$36,140	$68,707

Self-Propelled II Savings Resulting from 39 Foot Project by Trade Region and Project Year

Project Year	Self-Propelled II Tonnage per Year -South America	Savings per Year Transporting Manatee Harbor Bulk Fertilizer Tonnage - South America	Self-Propelled II Tonnage per Year - Japan/Australia/ New Zealand	Savings per Year Transporting Manatee Harbor Bulk Fertilizer Tonnage - Japan/Australia/	Self-Propelled II Tonnage per Year - China	Savings per Year Transporting Manatee Harbor Bulk Fertilizer Tonnage - China	Total Savings per Year on Self-Propelled II Vessels
Years 1 - 5	32,533	$1,215	149,116	$59,106	109,073	$66,938	$127,259
Years 6 - 10	34,013	$1,270	155,900	$61,795	114,035	$69,983	$133,048
Years 11 - 15	34,013	$1,270	155,900	$61,795	114,035	$69,983	$133,048
Years 16 - 20	34,013	$1,270	155,900	$61,795	114,035	$69,983	$133,048
Years 21 - 25	34,013	$1,270	155,900	$61,795	114,035	$69,983	$133,048
Years 26 - 30	34,013	$1,270	155,900	$61,795	114,035	$69,983	$133,048
Years 31 - 35	34,013	$1,270	155,900	$61,795	114,035	$69,983	$133,048
Years 36 - 40	34,013	$1,270	155,900	$61,795	114,035	$69,983	$133,048
Years 41 - 45	34,013	$1,270	155,900	$61,795	114,035	$69,983	$133,048
Years 46 - 50	34,013	$1,270	155,900	$61,795	114,035	$69,983	$133,048

Self-Propelled II Savings Resulting from 40 Foot Project by Trade Region and Project Year

Project Year	Self-Propelled II Tonnage per Year -South America	Savings per Year Transporting Manatee Harbor Bulk Fertilizer Tonnage - South America	Self-Propelled II Tonnage per Year - Japan/Australia/ New Zealand	Savings per Year Transporting Manatee Harbor Bulk Fertilizer Tonnage - Japan/Australia/	Self-Propelled II Tonnage per Year - China	Savings per Year Transporting Manatee Harbor Bulk Fertilizer Tonnage - China	Total Savings per Year on Self-Propelled II Vessels
Years 1 - 5	32,533	$1,215	149,116	$59,106	109,073	$66,938	$127,259
Years 6 - 10	34,013	$1,270	155,900	$61,795	114,035	$69,983	$133,048
Years 11 - 15	34,013	$1,270	155,900	$61,795	114,035	$69,983	$133,048
Years 16 - 20	34,013	$1,270	155,900	$61,795	114,035	$69,983	$133,048
Years 21 - 25	34,013	$1,270	155,900	$61,795	114,035	$69,983	$133,048
Years 26 - 30	34,013	$1,270	155,900	$61,795	114,035	$69,983	$133,048
Years 31 - 35	34,013	$1,270	155,900	$61,795	114,035	$69,983	$133,048
Years 36 - 40	34,013	$1,270	155,900	$61,795	114,035	$69,983	$133,048
Years 41 - 45	34,013	$1,270	155,900	$61,795	114,035	$69,983	$133,048
Years 46 - 50	34,013	$1,270	155,900	$61,795	114,035	$69,983	$133,048

Table 20: Savings Accruing to Inbound SP I Bulk Carriers Transporting Cement Clinker Imports to Manatee Harbor by Channel Depth, Trade Region, and Project Year

Self-Propelled I Savings Resulting from 38 Foot Project by Trade Region and Project Year

Project Year	Self-Propelled I Tonnage per Year -South America	Savings per Year Transporting Manatee Harbor Clinker Tonnage South America	Self-Propelled I Tonnage per Year - Greece	Savings per Year Transporting Manatee Harbor Clinker Tonnage Greece	Self-Propelled I Tonnage per Year - Thailand	Savings per Year Transporting Manatee Harbor Clinker Tonnage Thailand	Total Savings per Year on Self-Propelled I Vessels
Years 1 - 5	85,880	49,131	105,940	75,322	24,768	87,944	212,397
Years 6 - 10	93,011	53,210	114,736	81,576	26,824	95,246	230,033
Years 11 - 15	100,694	57,605	124,214	88,315	29,040	103,114	249,034
Years 16 - 20	109,011	62,364	134,474	95,609	31,439	111,631	269,604
Years 21 - 25	112,443	64,327	138,707	98,619	32,429	115,145	278,091
Years 26 - 30	112,443	64,327	138,707	98,619	32,429	115,145	278,091
Years 31 - 35	112,443	64,327	138,707	98,619	32,429	115,145	278,091
Years 36 - 40	112,443	64,327	138,707	98,619	32,429	115,145	278,091
Years 41 - 45	112,443	64,327	138,707	98,619	32,429	115,145	278,091
Years 46 - 50	112,443	64,327	138,707	98,619	32,429	115,145	278,091

Self-Propelled I Savings Resulting from 39 Foot Project by Trade Region and Project Year

Project Year	Self-Propelled I Tonnage per Year -South America	Savings per Year Transporting Manatee Harbor Clinker Tonnage South America	Self-Propelled I Tonnage per Year - Greece	Savings per Year Transporting Manatee Harbor Clinker Tonnage Greece	Self-Propelled I Tonnage per Year - Thailand	Savings per Year Transporting Manatee Harbor Clinker Tonnage Thailand	Total Savings per Year on Self-Propelled I Vessels
Years 1 - 5	85,880	$92,387	105,940	$141,638	24,768	$165,373	$399,399
Years 6 - 10	93,011	$100,058	114,736	$153,399	26,824	$179,105	$432,561
Years 11 - 15	100,694	$108,323	124,214	$166,070	29,040	$193,899	$468,292
Years 16 - 20	109,011	$117,271	134,474	$179,787	31,439	$209,915	$506,973
Years 21 - 25	112,443	$120,962	138,707	$185,447	32,429	$216,523	$522,933
Years 26 - 30	112,443	$120,962	138,707	$185,447	32,429	$216,523	$522,933
Years 31 - 35	112,443	$120,962	138,707	$185,447	32,429	$216,523	$522,933
Years 36 - 40	112,443	$120,962	138,707	$185,447	32,429	$216,523	$522,933
Years 41 - 45	112,443	$120,962	138,707	$185,447	32,429	$216,523	$522,933
Years 46 - 50	112,443	$120,962	138,707	$185,447	32,429	$216,523	$522,933

Self-Propelled I Savings Resulting from 40 Foot Project by Trade Region and Project Year

Project Year	Self-Propelled I Tonnage per Year -South America	Savings per Year Transporting Manatee Harbor Clinker Tonnage South America	Self-Propelled I Tonnage per Year - Greece	Savings per Year Transporting Manatee Harbor Clinker Tonnage Greece	Self-Propelled I Tonnage per Year - Thailand	Savings per Year Transporting Manatee Harbor Clinker Tonnage Thailand	Total Savings per Year on Self-Propelled I Vessels
Years 1 - 5	85,880	$130,763	105,940	$200,472	24,768	$165,373	$496,609
Years 6 - 10	93,011	$141,621	114,736	$217,118	26,824	$179,105	$537,843
Years 11 - 15	100,694	$153,319	124,214	$235,053	29,040	$193,899	$582,270
Years 16 - 20	109,011	$165,983	134,474	$254,468	31,439	$209,915	$630,366
Years 21 - 25	112,443	$171,208	138,707	$262,479	32,429	$216,523	$650,210
Years 26 - 30	112,443	$171,208	138,707	$262,479	32,429	$216,523	$650,210
Years 31 - 35	112,443	$171,208	138,707	$262,479	32,429	$216,523	$650,210
Years 36 - 40	112,443	$171,208	138,707	$262,479	32,429	$216,523	$650,210
Years 41 - 45	112,443	$171,208	138,707	$262,479	32,429	$216,523	$650,210
Years 46 - 50	112,443	$171,208	138,707	$262,479	32,429	$216,523	$650,210

Table 21: Savings Accruing to Inbound SP II Bulk Carriers Transporting Cement Clinker Imports to Manatee Harbor by Channel Depth, Trade Region, and Project Year

Self-Propelled II Savings Resulting from 38 Foot Project by Trade Region and Project Year

Project Year	Self-Propelled II Tonnage per Year -South America	Savings per Year Transporting Manatee Harbor Clinker Tonnage South America	Self-Propelled II Tonnage per Year - Greece	Savings per Year Transporting Manatee Harbor Clinker Tonnage Greece	Self-Propelled II Tonnage per Year - Thailand	Savings per Year Transporting Manatee Harbor Clinker Tonnage Thailand	Total Savings per Year on Self-Propelled II Vessels
Years 1 - 5	85,880	$32,921	105,940	$50,470	24,768	$58,928	$142,319
Years 6 - 10	93,011	$35,654	114,736	$54,661	26,824	$63,821	$154,136
Years 11 - 15	100,694	$38,599	124,214	$59,176	29,040	$69,093	$166,868
Years 16 - 20	109,011	$41,788	134,474	$64,064	31,439	$74,800	$180,652
Years 21 - 25	112,443	$43,103	138,707	$66,081	32,429	$77,155	$186,339
Years 26 - 30	112,443	$43,103	138,707	$66,081	32,429	$77,155	$186,339
Years 31 - 35	112,443	$43,103	138,707	$66,081	32,429	$77,155	$186,339
Years 36 - 40	112,443	$43,103	138,707	$66,081	32,429	$77,155	$186,339
Years 41 - 45	112,443	$43,103	138,707	$66,081	32,429	$77,155	$186,339
Years 46 - 50	112,443	$43,103	138,707	$66,081	32,429	$77,155	$186,339

Self-Propelled II Savings Resulting from 39 Foot Project by Trade Region and Project Year

Project Year	Self-Propelled II Tonnage per Year -South America	Savings per Year Transporting Manatee Harbor Clinker Tonnage South America	Self-Propelled II Tonnage per Year - Greece	Savings per Year Transporting Manatee Harbor Clinker Tonnage Greece	Self-Propelled II Tonnage per Year - Thailand	Savings per Year Transporting Manatee Harbor Clinker Tonnage Thailand	Total Savings per Year on Self-Propelled II Vessels
Years 1 - 5	85,880	$62,512	105,940	$95,836	24,768	$111,896	$270,244
Years 6 - 10	93,011	$67,702	114,736	$103,794	26,824	$121,187	$292,683
Years 11 - 15	100,694	$73,294	124,214	$112,367	29,040	$131,197	$316,859
Years 16 - 20	109,011	$79,349	134,474	$121,649	31,439	$142,034	$343,032
Years 21 - 25	112,443	$81,846	138,707	$125,479	32,429	$146,506	$353,831
Years 26 - 30	112,443	$81,846	138,707	$125,479	32,429	$146,506	$353,831
Years 31 - 35	112,443	$81,846	138,707	$125,479	32,429	$146,506	$353,831
Years 36 - 40	112,443	$81,846	138,707	$125,479	32,429	$146,506	$353,831
Years 41 - 45	112,443	$81,846	138,707	$125,479	32,429	$146,506	$353,831
Years 46 - 50	112,443	$81,846	138,707	$125,479	32,429	$146,506	$353,831

Self-Propelled II Savings Resulting from 40 Foot Project by Trade Region and Project Year

Project Year	Self-Propelled II Tonnage per Year -South America	Savings per Year Transporting Manatee Harbor Clinker Tonnage South America	Self-Propelled II Tonnage per Year - Greece	Savings per Year Transporting Manatee Harbor Clinker Tonnage Greece	Self-Propelled II Tonnage per Year - Thailand	Savings per Year Transporting Manatee Harbor Clinker Tonnage Thailand	Total Savings per Year on Self-Propelled II Vessels
Years 1 - 5	85,880	$89,254	105,940	$136,835	24,768	$111,896	$337,985
Years 6 - 10	93,011	$96,665	114,736	$148,196	26,824	$121,187	$366,048
Years 11 - 15	100,694	$104,650	124,214	$160,438	29,040	$131,197	$396,285
Years 16 - 20	109,011	$113,294	134,474	$173,690	31,439	$142,034	$429,018
Years 21 - 25	112,443	$116,860	138,707	$179,158	32,429	$146,506	$442,524
Years 26 - 30	112,443	$116,860	138,707	$179,158	32,429	$146,506	$442,524
Years 31 - 35	112,443	$116,860	138,707	$179,158	32,429	$146,506	$442,524
Years 36 - 40	112,443	$116,860	138,707	$179,158	32,429	$146,506	$442,524
Years 41 - 45	112,443	$116,860	138,707	$179,158	32,429	$146,506	$442,524
Years 46 - 50	112,443	$116,860	138,707	$179,158	32,429	$146,506	$442,524

Table 22: Savings Accruing to Inbound SP III Bulk Carriers Transporting Forest Product Imports to Manatee Harbor by Channel Depth, Trade Region, and Project Year

Self-Propelled III Savings Resulting from 38 Foot Project by Trade Region and Project Year		
Project Year	Self-Propelled III Tonnage per Year -Brazil	Savings per Year Transporting Manatee Harbor Forest Products Tonnage - Brazil
Years 1 - 5	111,231	$30,002
Years 6 - 10	143,182	$38,620
Years 11 - 15	183,611	$49,525
Years 16 - 20	235,457	$63,510
Years 21 - 25	258,199	$69,644
Years 26 - 30	258,199	$69,644
Years 31 - 35	258,199	$69,644
Years 36 - 40	258,199	$69,644
Years 41 - 45	258,199	$69,644
Years 46 - 50	258,199	$69,644
Self-Propelled III Savings Resulting from 39 Foot Project by Trade Region and Project Year		
Project Year	**Self-Propelled III Tonnage per Year -Brazil**	**Savings per Year Transporting Manatee Harbor Forest Products Tonnage - Brazil**
Years 1 - 5	111,231	$56,862
Years 6 - 10	143,182	$73,196
Years 11 - 15	183,611	$93,863
Years 16 - 20	235,457	$120,367
Years 21 - 25	258,199	$131,993
Years 26 - 30	258,199	$131,993
Years 31 - 35	258,199	$131,993
Years 36 - 40	258,199	$131,993
Years 41 - 45	258,199	$131,993
Years 46 - 50	258,199	$131,993
Self-Propelled III Savings Resulting from 40 Foot Project by Trade Region and Project Year		
Project Year	**Self-Propelled III Tonnage per Year -Brazil**	**Savings per Year Transporting Manatee Harbor Forest Products Tonnage - Brazil**
Years 1 - 5	111,231	$81,048
Years 6 - 10	143,182	$104,330
Years 11 - 15	183,611	$133,788
Years 16 - 20	235,457	$171,566
Years 21 - 25	258,199	$188,137
Years 26 - 30	258,199	$188,137
Years 31 - 35	258,199	$188,137
Years 36 - 40	258,199	$188,137
Years 41 - 45	258,199	$188,137
Years 46 - 50	258,199	$188,137

Yearly transportation savings by depth for all the benefiting vessel classes (bulk carriers transporting bulk fertilizer exports and cement clinker, forest product, cement, and limestone imports, and tankers transporting bunker fuel imports) are summed together and discounted to the base year of the project using the current federal rate of 5.875 percent. The total of the discounted yearly transportation savings at a given depth represents the total base year benefit of the project at that depth. Using the Federal discount rate and the fifty-year life of the project to annualize the benefits produces the Average Annual Equivalent (AAEQ) benefits of the project at each depth. **Table 23** presents the total discounted transportation savings and the AAEQ benefits for each potential channel depth.

Table 23: Total Discounted and Average Annual Equivalent Benefits for 38, 39, and 40 Feet of Project Depth at Manatee Harbor

	Channel Depth		
	38	39	40
Bulk Carriers Transporting Bulk Fertilizer Exports			
Self-Propelled II	$5,865,101	$10,914,726	$10,914,726
Self-Propelled III	$1,121,042	$2,170,847	$2,170,847
Total	$6,986,144	$13,085,574	$13,085,574
AAEQ	$435,516	$815,755	$815,755
Bulk Carriers Transporting Cement Clinker Imports			
Self-Propelled I	$4,060,145	$7,634,836	$9,493,093
Self-Propelled II	$2,720,550	$5,165,942	$6,460,861
Total	$6,780,695	$12,800,778	$15,953,954
AAEQ	$422,709	$798,001	$994,570
Bulk Carriers Transporting Forest Product Imports			
Self-Propelled III	$814,915	$1,544,474	$2,201,420
Total	$814,915	$1,544,474	$2,201,420
AAEQ	$50,802	$96,283	$137,237
Bulk Carriers Transporting Cement Imports			
Self-Propelled I	$922,751	$1,795,167	$1,837,581
Self-Propelled II	$1,071,896	$2,063,508	$2,110,746
Total	$1,994,648	$3,858,675	$3,948,327
AAEQ	$124,346	$240,550	$246,139
Bulk Carriers Transporting Limestone Imports			
Self-Propelled I	$138,845	$262,415	$383,917
Total	$138,845	$262,415	$383,917
AAEQ	$8,656	$16,359	$23,933
Tankers Transporting Bunker Fuel Imports			
Self-Propelled I	$13,432	$17,472	$17,472
Self-Propelled II	$4,997	$9,786	$14,381
Self-Propelled III	$14,379	$18,760	$18,760
Self-Propelled IV	$7,892	$10,312	$10,312
Total	$40,699	$56,331	$60,926
AAEQ	$2,537	$3,512	$3,798
Total for all Vessels			
Total	$16,755,945	$31,608,246	$35,634,119
AAEQ	$1,044,566	$1,970,458	$2,221,431

Addendum II. Delay Reduction Benefits

Appendix A. Economics

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Delay Reduction Benefits Analysis

1. INTRODUCTION

The U. S. Army Corps of Engineers (Corps) is investigating navigation improvements at Port Manatee, located on the eastern shore of Tampa Bay. These navigation improvements have been phased to accommodate the financial capability of the non-Federal project partner, the Manatee County Port Authority (MCPA). This investigation is estimating the benefits associated with Phase II navigation improvements, which include: (1) wideners at the entrance to the Port Manatee Channel at its junction with the Tampa Harbor Channel and (2) a variety of alternative turning basins within the Port Manatee harbor.

The following section provides background information on Port Manatee and the sequence of studies to address navigation problems and opportunities at the port. Subsequent sections explain the methodology, data, and results of benefit estimation for the alternative plans, consisting of various combinations of channel wideners and turning basins.

2. BACKGROUND

Port Manatee, which is owned and operated by MCPA, commenced operations in 1970. The Port initially served as a barge facility for bulk commodities. To provide access for commercial navigation, MCPA constructed the Port Manatee Channel, which extends approximately 15,850 feet in length from the Port harbor to the Tampa Bay Channel.

Federal involvement in the Port Manatee Channel commenced in 1974, when the U.S. Congress requested a review of the Tampa Harbor project. Based on the findings of that review, the Port Manatee Channel was adopted as a Federal channel subject to Federal maintenance. Congress authorized the Port Manatee project in the Water Resources Development Act (WRDA) of 1986. The authorized project provides for Federal maintenance of an existing channel and construction of a turning basin. Maintenance of the channel is authorized to a depth of 40 feet mean low water (MLW) and a width of 400 feet.

The Water Resources Development Act of 1990 (PL 101-640) modified the project through a Post-Authorization Change (PAC) dated April 1990. It established a new project cost at $27,589,000, with an estimated first Federal cost of $12,381,000 and an estimated non-Federal cost of $15,208,000.

In 1993 a Limited Reevaluation Report (LRR) split the authorized work in two phases. Per the LRR, Phase I would cost approximately $7,552,000 and Phase II would cost approximately $22,964,000. Phase I consisted of an entrance channel, extending from the main Tampa Harbor channel to the Manatee County port facilities at Manatee Harbor, with a length of 15,850 feet and a width of 400 feet at a depth of 40 feet. Phase I was completed in 1997.

An Engineering Documentation Report (EDR), dated December 2001, was prepared to document the design and cost for Phase II. The EDR Phase II provided revised engineering design and construction cost estimates entrance for the channel wideners along both the north and south sides of the channel at the intersection with the Tampa Harbor and the for relocation of the project 900-foot diameter turning basin at the northeastern end of the channel, dredged to the existing authorized depth of 40 feet. The project cost for the EDR was estimated at about $25,970,000 at December 2001 price levels.

The Phase II recommendation for the 900-foot turning basin was not implemented due to environmental concerns related to seagrass disturbance south of the channel's southern boundary as it enters the harbor. An Engineering Documentation Report (EDR), dated December 2001, was prepared to document the design and cost for Phase II for a modified turning basin. The EDR Phase II provided revised engineering design and construction cost estimates for: (1) wideners for the Port Manatee Channel at its intersection with the Tampa Harbor Channel and (2) relocation and resizing of the authorized 900-foot diameter, 40 feet MLW turning basin. The revised design located the turning basin north of the channel, tangential to the northern edge of the channel as it enters the harbor. This would effectively provide a 1,300 foot turning basin, consistent with 1,274 feet needed for the 775-foot Design Vessel selected for the EDR. The project cost for the Phase II EDR plan was estimated at approximately $25,970,000 (December 2001 price levels).

Based on the differences between the revised turning basin design and the authorized turning basin, the Corps determined that this LRR (and subsequent PAC) would be required for Phase II implementation. The purpose of this LRR is to provide a current estimate of project benefits (Phases I and II) and evaluate the engineering, economic, and environmental feasibility of the proposed Phase II navigation improvements.

3. PURPOSE AND SCOPE

This investigation is supporting the Phase II LRR and PAC by estimating the benefits of the alternative plans for channel wideners and a turning basin at Port Manatee. These improvements would enhance the efficiency of port operations and would improve the safety of commercial navigation in this waterway. The benefits of Phase I improvements are being updated in a separate investigation. Both sets of benefits are compared to the costs of their associated navigation improvements in the main body of the Phase II LRR and PAC.

Economic analyses documented in this appendix were conducted consistent with Federal statutes and Corps policy. This analysis focuses on the contributions of the alternative plans to National Economic Development (NED). Although the Port is an important contributor to the regional economy, Federal decision making regarding Federal investment in infrastructure improvements is based on anticipated NED effects. The NED effects of the alternative plans include reduced transportation costs for commodities carried on commercial vessels with consequent increases in the value of the national output of goods and services. Procedures for estimating NED effects are specified in the Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (U.S. Water Resources Council, 10 May 1983), the Planning Guidance Notebook Engineering Regulation (ER) 1105-2-100 (22 April 2000), and other Corps guidance, such as the National Economic Development Procedures Manual: Deep Draft Navigation (IWR Report 91-R-13, November 1991).

4. EXISTING CONDITIONS

The following profile of existing conditions at Port Manatee includes: Port facilities and operating practices, navigation in the entrance channel and in the harbor, and characteristics of the fleet which currently calls at Port Manatee.

4.1 Port Facilities

The layout of Port Manatee, which is owned and operated by the MCPA, is illustrated in Figure 1. The Port facilities are profiled in Table 1. As indicated in the figure and table, the Port has seven commercial berths with facilities for cruise ships and a wide variety of commodities. The Port has approximately ten major tenants plus a variety of smaller users. The major tenants include multinational corporations, such as Tropicana, LaFarge, Kinder-Morgan (formerly Packhoed), and Del Monte.

Figure 1: Current Configuration of Port Manatee

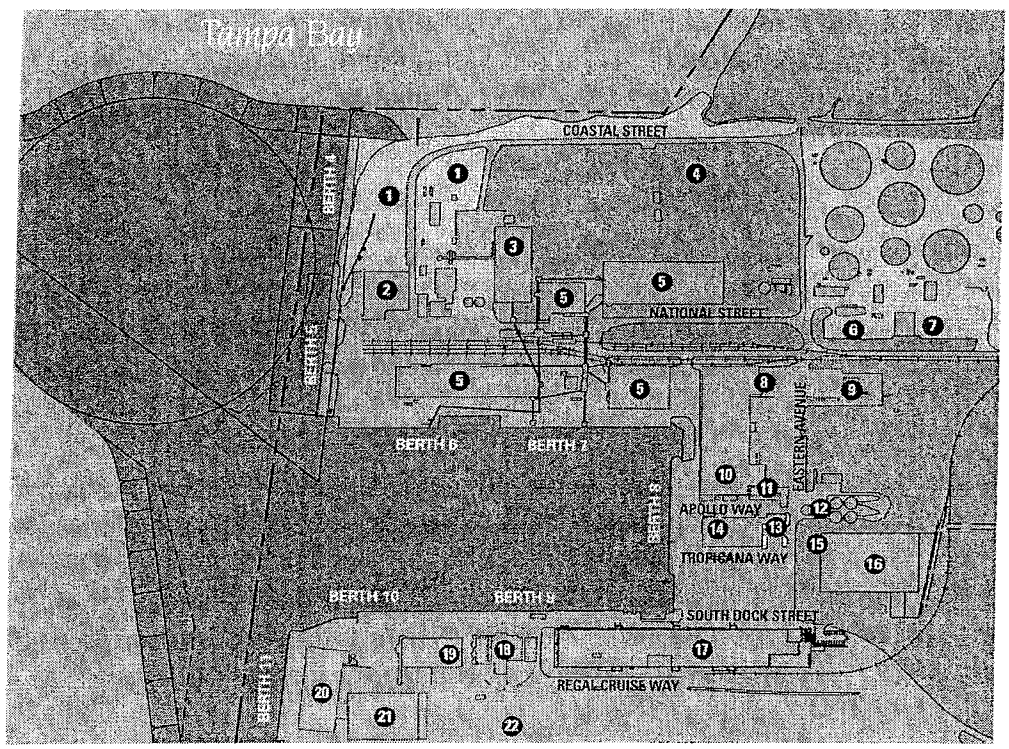


Table 1: Existing Port Facilities

Berth No.	Length (feet)	Depth (feet MLW)	Features	Cargo Handled
11	447	40	• Petroleum Pipeline • 58,000 sq. ft. warehouse	General Cargo, Break-Bulk Containers, Reefer, Liquid Bulk
10	506	40	• Petroleum Pipeline • Passenger Pavilion • 30,000 sq. ft. warehouse	General Cargo, Containers, Liquid Bulk, Break-Bulk, Passengers
9	737	40	• Petroleum pipeline • RO/RO Ramp • Cruise terminal • 171,000 sq. ft. warehouse	RO/RO, Passengers, General Cargo, Break-Bulk, Containers, Liquid Bulk, Project Cargo
8	650	40	• Petroleum Pipeline • Pneumatic cement discharge system • 4 silos (50,000 sq. ft. capacity) • 36,000 sq. ft. warehouse • 171,000 sq. ft. cold warehouse	General cargo, Containers, Break-Bulk, Freeze, Chill, RO/RO, Liquid Bulk, Project Cargo
7	831	40	• Petroleum Pipeline • 2 fixed-gantry conveyor loaders • 235,000 sq. ft. warehouse	Dry Bulk, Liquid Bulk, Break-Bulk
6	686	40	• Petroleum Pipeline • Covered clinker conveyor system • Rail connection • 35,000 sq. ft. warehouse	Dry Bulk, Liquid Bulk, Break-Bulk, Containers
5	350	20	• 35,000 sq. ft. warehouse	Dry Bulk

4.2 Port Operating Practices and Constraints

Port Manatee experiences significant vessel congestion due to a combination of: (1) physical conditions at the Port, (2) a large number of vessel calls relative to the size of the Port, and (3) operating constraints, which result from shippers desiring particular berths to access specific landside handling and storage facilities. Discussions with Port tenants and Port personnel, as well as observations of actual port operations revealed the operating restrictions and processing rules listed below. As will be explained later in this document, these practices have been quantified and included in this economic analysis to the extent possible.

1. Cruise ships currently call at the port from December through May only.
2. When multiple ships are waiting for a berth, vessels are typically moved into the first available berth based on the order of arrival. However, certain types of vessels are given priority regardless of arrival time. The order of priority is: (a) passenger ships, (b) perishables (fruit and juice), (c) vessels that are restricted to a specific berth due to handling or storage facilities, such as cement, clinker, fertilizer, and bunkers, and (d) all other vessel types.
3. Vessel length overall (LOA) at Berth 5 cannot exceed 350 feet and vessel draft cannot exceed 20 feet.
4. Combined vessel LOA at Berths 6 and 7 cannot exceed 1,100 feet if Berth 8 is occupied.
5. Combined vessel LOA at Berths 6 and 7 cannot exceed 1,192 feet if Berth 8 is vacant.
6. Vessel LOA at Berth 8 cannot exceed 550 feet if Berths 7 and 9 are both occupied.
7. Vessel LOA at Berth 8 cannot exceed 620 feet if either Berth 7 or Berth 9 are vacant.
8. Combined vessel LOA at Berths 9 and 10 cannot exceed 1,200 feet.
9. When a self-propelled Tropicana vessel is docked at Berth 8, and a self-propelled Cement vessel (which can only use Berth 8) is waiting to get into a berth, and Berth 9 is open, the Tropicana vessel will move to Berth 9, but a shift fee will be assessed against the Cement vessel.
10. Self-propelled Cement vessels can dock only at Berth 8 because it is the only berth equipped with a pneumatic cement discharge system below the dock surface, which connects to four silos used for storage of cement.
11. Self-propelled Clinker vessels can dock only at Berth 6 because it is the only berth equipped with a conveyor system to a cement mill with two storage silos.
12. Self-propelled fertilizer vessels can dock only at Berth 7 because it is the only berth equipped with two fixed gantry conveyor loaders required in the loading of fertilizer.

The combined effects of vessel congestion and the lack of redundant dock-side facilities has required Port officials to shift vessels from their preferred berths in an attempt to accommodate the greatest number of vessels and maximize the use of harbor facilities. However, in the absence of significant improvements to berths and dockside facilities, problems associated with in-port delays and slowed cargo transfer are expected to continue and to grow more severe in the future. Interviews with Port Manatee personnel, shipping agents, and carriers indicate that: (1) delays are relatively common and (2) diversions occur less frequently than delays. Decisions to divert to another port, which are made on an *ad hoc* basis, depend on a variety of factors, including: anticipated length of delay at Port Manatee, berth availability at the alternate port, and coordination with landside transportation.

4.3 Characteristics of Existing Fleet

The characteristics of the Port Manatee fleet are described below. These vessel characteristics pertain to with- and without-project conditions. As will be evident in the subsequent profiles of with- and without-project conditions, the number of calls of these vessels will differ for the two sets of conditions.

The characteristics of the fleet currently calling at Port Manatee, including vessel type, length, sailing draft, and cargo tonnage, were derived from individual vessel call data collected by MCPA. Existing fleet characteristics are based on 32 months of the Port's individual ship call data from January 1999 through August 2001. Five general types of vessels regularly call at Port Manatee: barges (tug assisted), liquid bulk vessels, general cargo vessels, container ships, and cruise ships. Vessels calling at Port Manatee typically carry a single commodity, therefore barges, liquid bulk, and general cargo vessels were further categorized according to the commodity carried. Therefore, vessel categorization is first based on the 20 main commodity types that are currently shipped through Port Manatee.

The four vessel types and 20 commodity types were used to create 26 vessel type/commodity type categories based on whether the commodities were transported by self-propelled vessel or barge. Within many of the 26 vessel type/commodity type categories there is variation in the size of vessels calling at Port Manatee. In order to analyze congestion and berth availability at the port, vessel categorization was further refined according to vessel size, including length, sailing draft, and dead-weight tons (DWT), tonnage carried, and flag, expanding the number of categories of vessels calling at Port Manatee to 50. Table 2 shows the 50 vessel/commodity categories, their average lengths and typical maximum sailing drafts. Table entry "NR" indicates that sailing drafts for that vessel type were not recorded.

4.4 Navigation in the Channel and Harbor

As part of this investigation, extensive coordination was conducted with the Tampa Pilots Association to understand current navigation practices in the Port Manatee Channel and in the harbor. The following discussion characterize how the pilots generally handle commercial vessels at Port Manatee, recognizing that depending on the physical conditions (i.e., wind and tides), vessel characteristics, and tug assistance, a particular pilot may prefer to operate vessels in their own particular fashion.

4.4.1 Navigation in the Port Manatee Channel

The intersection of the Tampa Bay channel and the Port Manatee channel is approximately a 90° degree angle. This sharp angle is difficult for large commercial vessels to negotiate. Winds and tidal currents, which run abeam of vessels entering/exiting the Port Manatee channel make conditions more challenging.

Two tugs are available at Port Manatee at all times to assist commercial traffic. Additional tugs can be procured as needed from the Tampa Bay port complex.

To promote safe navigation at Port Manatee, the Tampa Pilots have adopted guidelines for entering/exiting the channel. These guidelines are based on vessel draft, since tidal currents are the principal navigational challenge at this location. The guidelines are summarized below:

Table 2: Existing Fleet: Vessel Categories and Sizes				
Commodity Class	**Ship Type**	**LOA**	**Draft**	**DWT**
Aggregate	Barge I	240	NR	3,100
	Barge II	250	NR	3,100
Asphalt	Barge I	416	24	10,799
	Barge II	469	31	16,304
	Self-Propelled I	595	36	36,922
Bag Fertilizer	Barge I	195	NR	3,100
Bunker	Barge I	192	NR	758
	Barge II	449	33	14,037
	Barge III	489	37	18,819
	Self-Propelled I	586	36	35,107
	Self-Propelled II	731	39	74,709
	Self-Propelled III	683	35	59,153
	Self-Propelled IV	797	38	79,133
Cement	Self-Propelled I	550	39	3,000
	Self-Propelled II	615	39	3,000
Clinker	Self-Propelled I	583	38	26,097
	Self-Propelled II	620	38	31,625
Juice Concentrate	Self-Propelled I	555	29	29,071
	Self-Propelled II	546	33	27,484
Diesel	Barge I	506	31	21,163
	Self-Propelled I	606	36	39,320
Dolomite	Barge I	229	NR	3,000
	Barge II	243	NR	3,000
Fertilizer	Barge I	439	26	3,000
	Barge II	590	32	3,000
	Self-Propelled I	385	34	7,619
	Self-Propelled II	585	39	28,696
	Self-Propelled II	797	40	54,252
Forest Products	Self-Propelled I	365	29	6,419
	Self-Propelled II	518	31	20,601
	Self-Propelled III	596	39	32,744
	Self-Propelled IV	665	29	47,249
Fruit	Self-Propelled I	443	30	11,073

Table 2: Existing Fleet: Vessel Categories and Sizes				
Commodity Class	**Ship Type**	**LOA**	**Draft**	**DWT**
	Self-Propelled II	524	30	18,704
Granite	Self-Propelled I	736	29	54,023
Limestone	Self-Propelled I	797	40	53,111
Linerboard	Self-Propelled I	426	28	9,799
	Self-Propelled II	533	28	19,725
Miscellaneous	Self-Propelled I	370	28	6,311
	Self-Propelled II	553	38	22,129
	Self-Propelled III	610	38	30,059
Juice Not Concentrate	Self-Propelled I	499	30	16,056
	Self-Propelled II	498	32	15,956
Other	Barge I	168	20	3,100
	Barge II	420	20	3,100
	Self-Propelled I	359	32	5,744
	Self-Propelled II	567	34	23,926
Cruise Passengers	Cruise Vessel	611	26	40,446
Steel	Barge I	195	NR	3,000
	Self-Propelled I	527	34	19,040

- Vessels with drafts less than 27 feet can enter/exit at any time. These vessels typically have the assistance of one tug at the channel junction and two tugs in the harbor.
- Vessels with drafts greater than 27 feet must enter/exit at slack tide. These vessels typically have the assistance of two tugs at the channel junction and in the harbor.
- Vessels with lengths greater than 700 feet length over all (LOA) must enter/exit at slack tide and have the assistance of three tugs at the channel junction and in the harbor.
- Any reefer ship, which has greater maneuverability than most deep-draft carriers, can enter/exit the channel without tug assistance but would still require two tugs in the harbor.

Tampa Bay in the vicinity of Port Manatee has irregular tides with diurnal and semidiurnal characteristics. There can be two to four slack tides per day, and the slack tide can have a duration of two hours or five minutes. In general, the pilots attempt to transit the channel during slack tides to take advantage of low tidal current during peaks and troughs of the tidal cycle.

The difficult conditions at the channel junction have resulted in frequent groundings at this location. The pilots estimated that four groundings occur per year. Some are associated with mechanical failure; others are due to the channel junction and adverse navigation conditions.

The bay bottom is relatively soft, and there have been minimal damages associated with groundings. However, significant delays are experienced for the vessel and its assisting tugs as measures are taken to free the ship (e.g., discharged ballast, tide shift, tug repositioning, etc.). Several hours are typically required to free a grounded vessel at this location.

The Port Manatee channel is effectively one-way. Typically, two vessels could transit to/from entrance to berth during a given slack tide. However, if a vessel has a draft in excess of 36 feet, only one vessel would typically be able to transit during a single slack tide. The pilots prefer to keep up their speed when transiting the channel to the extent possible. This allows them greater maneuverability against tidal currents. However, the entrance into the harbor is curved and somewhat constrained, which requires the pilots to reduce their speed earlier than they would prefer.

4.4.2 Navigation in the Harbor

Port Manatee currently does not have a turning basin. Using the two tugs, which accompany all commercial vessels in the harbor (and sometimes a third tug), pilots turn vessels depending on the size of the vessel and prevailing conditions (particularly wind). Vessels can be turned before or after discharging their cargo, depending on unloading requirements of a particular vessel at a particular berth (i.e., "port side to" or "starboard side to" the berth).

The pilots can freely turn vessels smaller than 650 feet LOA in a rotational spin with two assisting tugs. This is performed west of the entrance to the Port's berthing basin.

For vessels larger than 650 feet LOA, the pilots describe the Port as being physically constrained. The vessels must be slowly turned with a three-point turn using the berthing basin. This turn is cumbersome and time-consuming. On some occasions with these vessels, the pilots encroach into berthing areas. If vessels are docked at Berth 6 or Berth 11, the usable area is even more limited, and the pilots execute turning maneuvers with little room for error.

Vessels longer than 800 feet LOA may not enter the Port Manatee channel/harbor due to pilot concerns about turning these vessels. The pilots strictly adhere to this operational constraint.

5. BENEFIT ESTIMATION METHODOLOGY

The benefits of navigation improvements under consideration in this investigation are based on savings in transportation cost to the nation. The benefits of the improvements are estimated by comparing transportation costs under with- and without-project conditions for the 50-year period of analysis (2005 – 2054).

As will be evident in this document, the benefit estimation methodology has been designed and conducted to generate the most likely estimates of the NED benefits of the navigation improvements, relying on observed existing conditions and practices as a guide to developing future scenarios. Given the large degree of uncertainty in projecting future conditions and practices in the ocean shipping industry, radical assumptions have been avoided, and each step of the evaluation was subjected to a strict test of reasonableness.

Port Manatee is frequently approached by carriers looking to take advantage of the Port's proximity to the Panama Canal (Port Manatee is the closest United States deepwater port to the Panama Canal), and access to the heavily populated East Coast Corridor through existing rail facilities and Interstate 95. This analysis does not consider the significant potential for increased traffic diverted from other ports to Port Manatee under with-project conditions.

6. COMMODITY FORECASTS

The benefits of navigation improvements to Port Manatee are based, in part, on the volume and mix of commodities anticipated to pass through the Port. The commodity forecasts for Port Manatee are presented below. These forecasts pertain to with- and without-project conditions.

The types and volume of commodities moved through Port Manatee are the main determinant of the types and number of vessels calling at the port. Commodity forecasts used in the benefit analysis are based on growth rates developed by the Jacksonville District staff based on historical growth at Port Manatee, and industry expert projected growth rates for various commodities within specific trade regions (District estimates). In addition, this analysis uses data from January 2000 to August 2001 that were unavailable to the District when they prepared their estimates. Including these additional years of data reduced base year commodity volumes and caused a general reduction in the commodity forecast used in this analysis, as compared to the commodity forecast in the previous District estimates.

6.1 Historical and Current Commodity Movements

Port Manatee's vessel call data from 1991 through 2002 were used to assess historical commodity movements and to assemble the base data for commodity projections. Table 3 shows commodity movements for calendar years 1991 - 2000. Overall, the types of commodities moving through Port Manatee have been consistent over the years, and the landside infrastructure at the port has been developed to support the movement of these commodities. Table 4 shows the 20 main commodity types handled at Port Manatee. These 20 commodity types also are used to characterize the existing fleet. The "miscellaneous" category includes commodities identified as such in the Port's data set. The "other" category includes a mix of commodities that constitute a very small portion of the total traffic through the Port.

Table 3: Historical Commodity Movements

Year	Calls	Tons (Short)
1991	520	4,307,552
1992	609	4,455,205
1993	512	3,650,006
1994	598	4,539,306
1995	547	3,622,811
1996	501	3,712,113
1997	518	4,466,923
1998	499	4,627,055
1999	533	4,774,297
2000	487	3,820,119

2001	502	5,533,000

Table 4: Historical Commodity Categories

Aggregate	Forest Products
Asphalt	Fresh Fruit
Bagged Fertilizer	Granite
Bulk Fertilizer	Limestone
Bunker Fuel	Linerboard
Cement	Miscellaneous
Cement Clinker	Not Concentrated Juice
Concentrated Juice	Other
Diesel Fuel	Passengers
Dolomite	Steel

6.2 Commodity Forecast Method

The representative base year was calculated with the most recent data and includes the recent reduction in commodity movements experienced in the year 2000. The commodity forecasts do not include non-recurring traffic, such as the existing steel pipe and bridge steel deliveries occurring at the port for off-site construction projects.

When applicable, growth rates developed in the District estimates were applied to the base year estimates to project future commodity traffic in the port. Forecast estimates for eleven commodities (approximately 20 percent of the port's base year tonnage total) were not available from the District estimates, and were extrapolated from the ten most recent years of port data. The commodities are listed below.

- Aggregate
- Concentrated Juice
- Dolomite
- Forest Products
- Linerboard
- Miscellaneous
- Fresh Fruit
- Granite
- Juice Not Concentrate
- Other
- Steel

Compound annual growth rates were estimated by determining the ten-year compound annual rate of growth from the commodity's lowest tonnage year to the commodity's average tonnage year. While this is a conservative method for estimating growth, continuation of compound annual growth rates for seven of the eleven commodities through the forecast period was determined to be unrealistic based on discussions with Port tenants regarding their corporate plans and landside throughput capacity. For this reason, projected tonnages for those seven commodities are held constant from Year 2007 to the end of the study period.

6.3 Commodity Projections

The base year (2005) of commodity projections were calculated by multiplying 2001 commodity volumes (actual) for each vessel type by the growth rates generated by the District. Projections for subsequent years were calculated by multiplying the annual tonnage for each vessel type by the growth rate. Due to the considerable uncertainty associated with a commodity forecast that extends to the year 2054 (the end of the period of analysis), projected commodity tonnages are held constant from year 2022 (17 years into the period of analysis) for the remaining 32 years of the period of analysis. Table 5 shows the calculated base year and commodity forecasts for selected years, and Table 6 shows the compound annual rates of growth used in generating the commodity forecasts for selected years. In Table 5 and Table 6, limestone volumes increase dramatically from the 2001 actual data. These volumes are associated with the operations of the Vulcan Materials Company, which imports crushed limestone from Mexico. Vulcan has greatly expanded it limestone shipments through Port Manatee following settlement of lease agreements with the Port and installation of new landside handling and storage facilities.

Table 5: Base Year Commodity Data and Commodity Forecast (With- and Without-Project Conditions)						
Commodity Type	**2001 Adj**	**2005 Base Year**	**2007**	**2012**	**2017**	**2022**
Aggregate	160,355	227,101	286,404	286,404	286,404	286,404
Asphalt	105,857	108,740	110,707	115,779	121,084	126,631
Bagged Fertilizer	1,806	2,308	2,308	2,308	2,308	2,308
Bunker Fuel	1,601,425	1,679,530	1,733,705	1,876,912	2,031,947	2,199,788
Cement	283,497	297,324	306,914	332,266	359,712	389,424
Clinkers	423,335	443,983	458,304	496,160	537,144	581,513
Conc Juice	55,220	65,433	73,271	97,223	129,006	171,178
Diesel Fuel	74,885	77,614	79,488	84,373	89,558	95,062
Dolomite	175,592	197,119	212,917	258,176	313,055	379,599
Bulk Fertilizer	644,642	823,880	823,880	823,880	823,880	823,880
Forest Products	100,347	162,578	224,268	224,268	224,268	224,268
Fresh Fruit	304,340	334,794	356,771	418,233	490,285	574,749
Granite	27,368	36,080	43,379	43,379	43,379	43,379
Limestone	68,984	500,000	500,000	500,000	500,000	500,000
Linerboard	50,066	84,626	120,080	120,080	120,080	120,080
Miscellaneous	35,198	90,507	169,873	169,873	169,873	169,873
Juice Not Concentrate	151,142	166,265	177,180	207,703	243,485	285,432
Other	56,651	74,686	89,796	89,796	89,796	89,796
Steel	15,786	26,469	37,356	37,356	37,356	37,356
Totals	4,336,498	5,399,037	5,806,602	6,184,171	6,612,620	7,100,721

Table 6: Commodity Forecast
Compound Annual Growth Rates
(With- and Without-Project Conditions)

Commodity Type	2002 - 2005	2005 - 2007	2007 - 2012	2012 - 2017	2017 - 2022	2022 – 2054
Aggregate	12.3%	12.3%	0.0%	0.0%	0.0%	0.0%
Asphalt	0.9%	0.9%	0.9%	0.9%	0.9%	0.0%
Bagged Fertilizer	8.5%	0.0%	0.0%	0.0%	0.0%	0.0%
Bunker Fuel	1.6%	1.6%	1.6%	1.6%	1.6%	0.0%
Cement	1.6%	1.6%	1.6%	1.6%	1.6%	0.0%
Clinkers	1.6%	1.6%	1.6%	1.6%	1.6%	0.0%
Conc Juice	5.8%	5.8%	5.8%	5.8%	5.8%	0.0%
Diesel Fuel	1.2%	1.2%	1.2%	1.2%	1.2%	0.0%
Dolomite	3.9%	3.9%	3.9%	3.9%	3.9%	0.0%
Bulk Fertilizer	8.5%	0.0%	0.0%	0.0%	0.0%	0.0%
Forest Products	17.4%	17.4%	0.0%	0.0%	0.0%	0.0%
Fresh Fruit	3.2%	3.2%	3.2%	3.2%	3.2%	0.0%
Granite	9.7%	9.7%	0.0%	0.0%	0.0%	0.0%
Limestone	93.5%	0.0%	0.0%	0.0%	0.0%	0.0%
Linerboard	19.1%	19.1%	0.0%	0.0%	0.0%	0.0%
Miscellaneous	37.0%	37.0%	0.0%	0.0%	0.0%	0.0%
Juice Not Concentrate	3.2%	3.2%	3.2%	3.2%	3.2%	0.0%
Other	9.7%	9.7%	0.0%	0.0%	0.0%	0.0%
Steel	18.8%	18.8%	0.0%	0.0%	0.0%	0.0%

7. WITHOUT-PROJECT CONDITIONS

For without-project conditions, existing conditions are expected to prevail through the period of analysis with respect to Port operating practices and constraints, and navigation in the Port Manatee Channel and in the harbor. It is expected that landside handling and storage capacity will be augmented consistent with the increased flow of commodities.

It is assumed that under without-project conditions the volumes and mix of commodities in the above forecast will be carried on the mix of vessels profiled in Table 2. However, under without-project conditions, channel depths in the Port Manatee Channel and in the harbor are assumed to be constrained to 37 feet, consistent with the pre-Phase I project depth. As indicated in Table 7, which expands Table 2, this would require sailing drafts of the existing fleet to be constrained to 34 feet, allowing three feet of underkeel clearance.

7.1 Without-Project Fleet Forecast

Characteristics of the existing fleet were used to forecast future fleet characteristics. The projected future fleet maintains most of the characteristics of the existing fleet including vessel type and length. Sailing drafts are constrained by channel dimensions assumed under without-project conditions. The projected number of port calls is based on the portion of tonnage carried by the various vessel types and the growth of commodity traffic.

The without-project fleet forecast was generated by calculating annual tonnage for each of the 50 vessel types for a representative base year derived from 1999 – August 2001 data. Because there are no major changes expected in the types of commodities moving through the port, there are no major changes in vessel types projected for the fleet. Port data from 1990 through 2000 indicates a trend of increasing vessel size (length and sailing draft), but this trend was not applied to the projected fleet because of limited information to describe the trend, uncertainty over whether the trend would continue, and port physical limitations. Commodity deliveries known to have a specific termination date, such as the steel pipe deliveries for a local pipeline construction project and steel deliveries for a local bridge construction project, were not included in the commodity or fleet projections. Calls that for whatever reason did not have sufficient data, such as missing tonnage or vessel length information were not included in the fleet forecast. Also, tug movements in and out of the port and berth usage by the local yacht manufacturer were not included in the fleet forecasts or in the benefit calculations.

The method used to forecast the characteristics of the future fleet is based on the existing 50 vessel categories, the portion of tonnage carried by each category, and projected commodity movements through the port. Each of the 50 vessel categories was allocated a proportional share of the total tonnage of the commodity traffic related to that vessel category, based on the 1999 – 2001 port data. Average commodity tonnage per call for each vessel category also is calculated from the same port data. Table 8 shows the average tonnage per call and proportional share of commodity traffic for each vessel type under without-project conditions.

The base year tonnage per vessel call is calculated as the weighted average tonnage per vessel call for calls made between January 1999 and August 2001. The base year tonnage per call for each vessel type is multiplied by the base year annual calls for that vessel type to calculate the total base year tonnage for that vessel type. Because the base year is a calculated annual value, not an observed annual value, fractional vessel calls were not rounded. Annual growth rates for specific commodity types identified in the District estimates were applied to the base year, with the exceptions of fertilizer, limestone, and cruise ships. Table 9 shows tonnages for each vessel type for the base year and selected forecast years for with- and without-project conditions.

Table 7: Sailing Drafts of Vessels Under Without- and With-Project Conditions

Commodity Class	Ship Type	LOA	Draft (without)	Draft (with)
Aggregate	Barge I	240	NR	NR
	Barge II	250	NR	NR
Asphalt	Barge I	416	24	24
	Barge II	469	31	31
	Self-Propelled I	595	34	36
Bag Fertilizer	Barge I	195	NR	NR
Bunker	Barge I	192	NR	NR
	Barge II	449	33	33
	Barge III	489	34	37
	Self-Propelled I	586	34	36
	Self-Propelled II	731	34	37
	Self-Propelled III	683	34	35
	Self-Propelled IV	797	34	37
Cement	Self-Propelled I	550	34	37
	Self-Propelled II	615	34	37
Clinker	Self-Propelled I	583	34	37
	Self-Propelled II	620	34	37
Juice Concentrate	Self-Propelled I	555	29	29
	Self-Propelled II	546	33	33
Diesel	Barge I	506	31	31
	Self-Propelled I	606	34	36
Dolomite	Barge I	229	NR	NR
	Barge II	243	NR	NR
Fertilizer	Barge I	439	26	26
	Barge II	590	32	32
	Self-Propelled I	385	34	34
	Self-Propelled II	585	34	37
	Self-Propelled II	797	34	37
Forest Products	Self-Propelled I	365	29	29
	Self-Propelled II	518	31	31

Table 7: Sailing Drafts of Vessels Under Without- and With-Project Conditions

Commodity Class	Ship Type	LOA	Draft (without)	Draft (with)
	Self-Propelled III	596	34	37
	Self-Propelled IV	665	29	29
Fruit	Self-Propelled I	443	30	30
	Self-Propelled II	524	30	30
Granite	Self-Propelled I	736	29	29
Limestone	Self-Propelled I	797	34	37
Linerboard	Self-Propelled I	426	28	28
	Self-Propelled II	533	28	28
Miscellaneous	Self-Propelled I	370	28	28
	Self-Propelled II	553	34	37
	Self-Propelled III	610	34	37
Juice Not Concentrate	Self-Propelled I	499	30	30
	Self-Propelled II	498	32	32
Other	Barge I	168	20	20
	Barge II	420	20	20
	Self-Propelled I	359	32	32
	Self-Propelled II	567	34	34
Cruise Passengers	Cruise Vessel	611	26	26
Steel	Barge I	195	NR	NR
	Self-Propelled I	527	34	34

Table 8: Vessel Tonnage Per Call and Vessel Class Share of Commodity (With- and Without-Project Conditions)

Ship class	Ship Type	Average Tonnage (with)	Average Tonnage (without)	Share	
Aggregate	Barge I	4,278	4,278	89%	
	Barge II	4,258	4,258	11%	100%
Asphalt	Barge I	5,157	5,157	19%	
	Barge II	13,557	13,557	81%	100%
	Self-Propelled I	21,595	21,595	100%	100%
Bag Fertilizer	Barge I	963	963	100%	100%

Table 8: Vessel Tonnage Per Call and Vessel Class Share of Commodity (With- and Without-Project Conditions)

Ship class	Ship Type	Average Tonnage (with)	Average Tonnage (without)	Share	
Bunker	Barge I	1,934	1,934	4%	
	Barge II	15,486	15,486	54%	
	Barge III	16,957	14,667	42%	100%
	Self-Propelled I	30,678	30,678	3%	
	Self-Propelled II	49,962	43,967	28%	
	Self-Propelled III	30,656	32,946	6%	
	Self-Propelled IV	49,323	44,390	63%	100%
Cement	Self-Propelled I	24,235	21,327	38%	
	Self-Propelled II	33,226	29,239	62%	100%
Clinker	Self-Propelled I	34,871	31,384	53%	
	Self-Propelled II	41,237	37,113	47%	100%
Juice Concentrate	Self-Propelled I	6,450	6,450	13%	
	Self-Propelled II	7,524	7,524	87%	100%
Diesel	Barge I	6,490	6,490	100%	100%
	Self-Propelled I	8,132	8,132	100%	100%
Dolomite	Barge I	1,922	1,922	11%	
	Barge II	4,229	4,229	89%	100%
Fertilizer	Barge I	7,294	7,294	45%	
	Barge II	18,134	18,134	55%	100%
	Self-Propelled I	7,820	7,820	26%	
	Self-Propelled II	13,507	11,886	38%	
	Self-Propelled II	17,543	14,912	36%	100%
Forest Products	Self-Propelled I	2,259	2,259	19%	
	Self-Propelled II	4,465	4,465	18%	
	Self-Propelled III	5,431	4,779	55%	
	Self-Propelled IV	6,628	6,628	7%	100%
Fruit	Self-Propelled I	4,172	4,172	33%	
	Self-Propelled II	5,446	5,446	67%	100%
Granite	Self-Propelled I	24,327	24,327	100%	100%
Limestone	Self-Propelled I	26,280	22,338	100%	100%
Linerboard	Self-Propelled I	4,714	4,714	60%	
	Self-Propelled II	5,338	5,338	40%	100%
Miscellaneous	Self-Propelled I	88	88	3%	

Table 8: Vessel Tonnage Per Call and Vessel Class Share of Commodity (With- and Without-Project Conditions)

Ship class	Ship Type	Average Tonnage (with)	Average Tonnage (without)	Share	
	Self-Propelled II	735	661	1%	
	Self-Propelled III	45,002	40,502	96%	100%
Juice Not Concentrate	Self-Propelled I	12,769	12,769	67%	
	Self-Propelled II	8,993	8,993	33%	100%
Other	Barge I	363	363	7%	
	Barge II	4,820	4,820	93%	100%
	Self-Propelled I	2,896	2,896	35%	
	Self-Propelled II	13,069	13,069	65%	100%
Steel	Barge I	1,341	1,341	100%	100%
	Self-Propelled I	6,793	6,793	100%	100%

Table 9: Projected Commodities Distributed to Vessels (With- and Without-Project Conditions)

Commodity Type	Ship Type	Base Year	Projected Year 2005	2007	2012	2017	2022
Aggregate	Barge I	142,792	202,229	255,036	255,036	255,036	255,036
	Barge II	17,563	24,873	31,368	31,368	31,368	31,368
Asphalt	Barge I	15,470	15,891	16,179	16,920	17,695	18,506
	Barge II	66,092	67,892	69,120	72,287	75,599	79,063
	Self-Propelled I	24,295	24,957	25,408	26,572	27,789	29,063
Bag Fertilizer	Barge I	1,806	2,308	2,308	2,308	2,308	2,308
Bunker	Barge I	18,858	19,778	20,416	22,102	23,928	25,904
	Barge II	278,746	292,341	301,771	326,698	353,684	382,898
	Barge III	216,207	226,752	234,066	253,401	274,332	296,992
	Self-Propelled I	34,513	36,196	37,364	40,450	43,791	47,409
	Self-Propelled II	299,774	314,394	324,536	351,343	380,364	411,782
	Self-Propelled III	68,975	72,339	74,673	80,841	87,518	94,747
	Self-Propelled IV	684,352	717,729	740,880	802,078	868,330	940,056
Cement	Self-Propelled I	109,058	114,377	118,067	127,819	138,377	149,807

Table 9: Projected Commodities Distributed to Vessels (With- and Without-Project Conditions)

Commodity Type	Ship Type	Base Year	Projected Year 2005	2007	2012	2017	2022
	Self-Propelled II	174,439	182,947	188,848	204,447	221,334	239,617
Clinker	Self-Propelled I	222,305	233,148	240,668	260,548	282,069	305,368
	Self-Propelled II	201,030	210,835	217,636	235,613	255,075	276,144
Concrete	Self-Propelled I	7,256	8,598	9,628	12,775	16,951	22,493
	Self-Propelled II	47,964	56,835	63,643	84,448	112,055	148,686
Diesel	Barge I	53,538	55,489	56,829	60,321	64,028	67,963
	Self-Propelled I	21,347	22,125	22,659	24,052	25,530	27,099
Dolomite	Barge I	20,183	22,658	24,473	29,676	35,984	43,632
	Barge II	155,409	174,462	188,444	228,500	277,071	335,966
Fertilizer	Barge I	10,941	13,983	13,983	13,983	13,983	13,983
	Barge II	13,600	17,382	17,382	17,382	17,382	17,382
	Self-Propelled I	158,363	202,395	202,395	202,395	202,395	202,395
	Self-Propelled II	238,065	304,257	304,257	304,257	304,257	304,257
	Self-Propelled II	223,673	285,864	285,864	285,864	285,864	285,864
Forest Products	Self-Propelled I	19,486	31,570	43,550	43,550	43,550	43,550
	Self-Propelled II	18,420	29,843	41,167	41,167	41,167	41,167
	Self-Propelled III	54,985	89,085	122,888	122,888	122,888	122,888
	Self-Propelled IV	7,456	12,080	16,664	16,664	16,664	16,664
Fruit	Self-Propelled I	100,120	110,138	117,368	137,588	161,290	189,077
	Self-Propelled II	204,220	224,655	239,403	280,646	328,994	385,672
Granite	Self-Propelled I	27,368	36,080	43,379	43,379	43,379	43,379
Limestone	Self-Propelled I	68,984	500,000	500,000	500,000	500,000	500,000
Linerboard	Self-Propelled I	30,050	50,793	72,073	72,073	72,073	72,073
	Self-Propelled II	20,016	33,833	48,088	48,088	48,088	48,088
Miscellaneous	Self-Propelled I	896	2,303	4,323	4,323	4,323	4,323
	Self-Propelled II	551	1,417	2,660	2,660	2,660	2,660
	Self-Propelled III	33,751	86,787	162,890	162,890	162,890	162,890
Juice Not Concentrate	Self-Propelled I	100,558	110,620	117,881	138,189	161,996	189,904
	Self-Propelled II	50,584	55,646	59,298	69,514	81,490	95,528
Other	Barge I	272	359	432	432	432	432
	Barge II	3,615	4,766	5,730	5,730	5,730	5,730
	Self-Propelled I	18,459	24,335	29,259	29,259	29,259	29,259
	Self-Propelled II	34,305	45,226	54,375	54,375	54,375	54,375

Table 9: Projected Commodities Distributed to Vessels (With- and Without-Project Conditions)

Commodity Type	Ship Type	Base Year	Projected Year 2005	2007	2012	2017	2022
Passengers	Cruise V	-	-	-	-	-	-
Steel	Barge I	503	843	1,190	1,190	1,190	1,190
	Self-Propelled I	15,283	25,625	36,166	36,166	36,166	36,166
Totals		4,336,498	5,399,037	5,806,602	6,184,171	6,612,620	7,100,721

Future vessel calls are projected by distributing projected commodity traffic among vessel categories according to the share allocated to that vessel category[1]. For those commodities that have projected tonnage increases, an additional vessel call is projected when total tonnage allocated to that vessel category increases by 50 percent or more of the average commodity tonnage per call. When tonnage increases are less than 50 percent of the average commodity tonnage per call, it is assumed that the growth in tonnage is spread across the existing fleet in that vessel category.

This approach to forecasting vessel calls recognizes that vessels may be loaded more fully to accommodate increased commodity traffic. Due to the considerable uncertainty associated with a fleet forecast that extends to the year 2054 (the end of the study period), projected vessel calls are held constant from year 2024 (20 years into the study period) to year 2054. Table 10 shows actual and projected vessel calls for selected years under without-project conditions.

Table 10: Projected Vessel Calls Under Without-Project Conditions

Ship Class	Ship Type	Actual 1999	Actual 2000	Projected 2005	2007	2012	2017	2022
Aggregate	Barge I	37	18	47	60	60	60	60
	Barge II	11	0	6	7	7	7	7
Asphalt	Barge I	4	4	3	3	3	3	4
	Barge II	3	5	5	5	5	6	6
	Self-Propelled I	3	-	1	1	1	1	1
Bag Fertilizer	Barge I	3	2	2	2	2	2	2
Bunker	Barge I	21	5	10	11	11	12	13
	Barge II	24	13	19	19	21	23	25
	Barge III	12	11	15	16	17	19	20

[1] Cruise ships are expected to make 39 calls per year, each year, in accordance with current plans and arrangements with the Port Authority.

Table 10: Projected Vessel Calls Under Without-Project Conditions

Ship Class	Ship Type	Actual 1999	Actual 2000	Projected 2005	Projected 2007	Projected 2012	Projected 2017	Projected 2022
	Self-Propelled I	0	0	1	1	1	1	2
	Self-Propelled II	12	2	7	7	8	9	9
	Self-Propelled III	3	2	2	2	2	3	3
	Self-Propelled IV	8	21	16	17	18	20	21
Cement	Self-Propelled I	5	2	5	6	6	6	7
	Self-Propelled II	6	8	6	6	7	8	8
Clinker	Self-Propelled I	9	6	7	8	8	9	10
	Self-Propelled II	7	6	6	6	6	7	7
Juice Concentrate	Self-Propelled I	0	3	1	1	2	3	3
	Self-Propelled II	8	7	8	8	11	15	20
Diesel	Barge I	6	11	9	9	9	10	10
	Self-Propelled I	5	0	3	3	3	3	3
Dolomite	Barge I	28	0	12	13	15	19	23
	Barge II	35	38	41	45	54	66	79
Fertilizer	Barge I	1	2	2	2	2	2	2
	Barge II	1	0	1	1	1	1	1
	Self-Propelled I	22	22	26	26	26	26	26
	Self-Propelled II	17	16	26	26	26	26	26
	Self-Propelled II	23	5	19	19	19	19	19
Forest Products	Self-Propelled I	3	13	14	19	19	19	19
	Self-Propelled II	5	6	7	9	9	9	9
	Self-Propelled III	1	13	19	26	26	26	26
	Self-Propelled IV	0	1	2	3	3	3	3
Fruit	Self-Propelled I	12	43	26	28	33	39	45
	Self-Propelled II	45	25	41	44	52	60	71
Granite	Self-Propelled I	0	3	1	2	2	2	2
Limestone	Self-Propelled I	0	3	22	22	22	22	22
Linerboard	Self-Propelled I	10	4	11	15	15	15	15
	Self-Propelled II	3	5	6	9	9	9	9
Miscellaneous	Self-Propelled I	17	11	26	49	49	49	49
	Self-Propelled II	0	1	2	4	4	4	4
	Self-Propelled III	0	0	2	4	4	4	4
Juice Not Concentrate	Self-Propelled I	12	10	9	9	11	13	15
	Self-Propelled II	3	5	6	7	8	9	11

Ship Class	Ship Type	Actual		Projected				
		1999	2000	2005	2007	2012	2017	2022
Other	Barge I	0	0	1	1	1	1	1
	Barge II	0	1	1	1	1	1	1
	Self-Propelled I	3	4	8	10	10	10	10
	Self-Propelled II	3	-	3	4	4	4	4
Cruise Passengers	Cruise Vess	29	46	39	39	39	39	39
Steel	Barge I	1	0	1	1	1	1	1
	Self-Propelled I	4	2	4	5	5	5	5
Totals		**465**	**405**	**557**	**641**	**678**	**730**	**782**

Table 10: Projected Vessel Calls Under Without-Project Conditions

8. WITH-PROJECT CONDITIONS (ALTERNATIVE PLANS)

The alternative plans considered in this analysis combine channel wideners at the entrance to the Port Manatee Channel with four turning basin configurations. A single widener design is under consideration, which was developed using ship simulation analyses conducted by the Corps Waterways Experiment Station (with extensive input from the Tampa Pilots Association). As part of the with-project conditions, the Port Manatee Channel and harbor is assumed to remain at the authorized 40-foot MLW depth. The following turning basin configurations are under consideration in combination with the wideners. The proposed improvements are assumed to prevail over the 50-year period of analysis.

- **A-3.** 900-foot turning basin tangent to the south side of the channel.
- **A-7.** 900-foot turning basin tangent to -100' from the north side of the channel (effective 1200'x 900')
- **A-4.** 900-foot turning basin tangent to the north side of the channel in front of berths 4 and 5 (as recommended in a previous EDR 1300' x 900').
- **A-6.** 1,200-foot turning basin tangent to the south side of the channel.

For with-project conditions, some analytical inputs were the same as those used for without-project conditions; others differed. The analytical inputs that are the same as without-project conditions include: Port facilities, Port operating practices and constraints, mix of vessels, and commodity forecasts. The analytical inputs that are differ from without-project conditions include the number of vessels calling at the Port and anticipated navigation practices with wideners and the alternative turning basin configurations. These departures from without-project conditions are the basis for estimating the benefits of the alternative plans. The with-project vessels calls and navigation practices are discussed below.

8.1 Without-Project Fleet Forecast

Under with-project conditions, the depth of the Port Manatee Channel and harbor is assumed to be 40 feet. This allows some vessels in the Port Manatee fleet (per Table 2) to be more fully loaded than under without-project conditions. As a result, the vessels which are restricted by the without-project channel depths can carry more tonnage under with-project conditions, as evident in Table 8. The projected vessel calls under with-project conditions are contained in Table 11. The calls were estimated using the same methodology that was applied to without-project conditions. The forecasted volume and mix of commodities (Table 5) was distributed to vessels carrying tonnages consistent with the average tonnage per vessel shown in Table 8, applying the commodity-to-vessel distribution shown in Table 9. Comparison of Table 10 with Table 11 indicates the reduced number of calls that would be expected with more tons carried on vessels that are constrained by the without-project condition channel dimensions.

Table 11: Projected Vessel Calls at Port Manatee (With-Project)

Ship Class	Ship Type	Actual		Projected				
		1999	2000	2005	2007	2012	2017	2022
Aggregate	Barge I	37	18	47	60	60	60	60
	Barge II	11	0	6	7	7	7	7
Asphalt	Barge I	4	4	3	3	3	3	4
	Barge II	3	5	5	5	5	6	6
	Self-Propelled I	3	-	1	1	1	1	1
Bag Fertilizer	Barge I	3	2	2	2	2	2	2
Bunker	Barge I	21	5	10	11	11	12	13
	Barge II	24	13	19	19	21	23	25
	Barge III	12	11	13	14	15	16	18
	Self-Propelled I	0	0	1	1	1	1	2
	Self-Propelled II	12	2	6	6	7	8	8
	Self-Propelled III	3	2	2	2	3	3	3
	Self-Propelled IV	8	21	15	15	16	18	19
Cement	Self-Propelled I	5	2	5	5	5	6	6
	Self-Propelled II	6	8	6	6	6	7	7
Clinker	Self-Propelled I	9	6	7	7	7	8	9
	Self-Propelled II	7	6	5	5	6	6	7
Juice Concentrate	Self-Propelled I	0	3	1	1	2	3	3
	Self-Propelled II	8	7	8	8	11	15	20
Diesel	Barge I	6	11	9	9	9	10	10
	Self-Propelled I	5	0	3	3	3	3	3
Dolomite	Barge I	28	0	12	13	15	19	23
	Barge II	35	38	41	45	54	66	79

Table 11: Projected Vessel Calls at Port Manatee (With-Project)								
Ship Class	Ship Type	Actual		Projected				
		1999	2000	2005	2007	2012	2017	2022
Fertilizer	Barge I	1	2	2	2	2	2	2
	Barge II	1	0	1	1	1	1	1
	Self-Propelled I	22	22	26	26	26	26	26
	Self-Propelled II	17	16	23	23	23	23	23
	Self-Propelled II	23	5	16	16	16	16	16
Forest Products	Self-Propelled I	3	13	14	19	19	19	19
	Self-Propelled II	5	6	7	9	9	9	9
	Self-Propelled III	1	13	16	23	23	23	23
	Self-Propelled IV	0	1	2	3	3	3	3
Fruit	Self-Propelled I	12	43	26	28	33	39	45
	Self-Propelled II	45	25	41	44	52	60	71
Granite	Self-Propelled I	0	3	1	2	2	2	2
Limestone	Self-Propelled I	0	3	19	19	19	19	19
Linerboard	Self-Propelled I	10	4	11	15	15	15	15
	Self-Propelled II	3	5	6	9	9	9	9
Miscellaneous	Self-Propelled I	17	11	26	49	49	49	49
	Self-Propelled II	0	1	2	4	4	4	4
	Self-Propelled III	0	0	2	4	4	4	4
Juice Not Concentrate	Self-Propelled I	12	10	9	9	11	13	15
	Self-Propelled II	3	5	6	7	8	9	11
Other	Barge I	0	0	1	1	1	1	1
	Barge II	0	1	1	1	1	1	1
	Self-Propelled I	3	4	8	10	10	10	10
	Self-Propelled II	3	-	3	4	4	4	4
Cruise Passengers	Cruise Vess	29	46	39	39	39	39	39
Steel	Barge I	1	0	1	1	1	1	1
	Self-Propelled I	4	2	4	5	5	5	5
Totals		**465**	**405**	**540**	**621**	**659**	**709**	**762**

8.2 Navigation in the Channel and Harbor Under With-Project Conditions

Representatives of the Tampa Pilots Association were queried about navigation in the Port Manatee Channel and in the harbor under with-project conditions. Specifically, they were asked how their navigation practices might change with the channel wideners and with the alternative turning basin configurations. Their responses are summarized below, recognizing that depending on the physical conditions (i.e., wind and tides), vessel characteristics, and tug assistance, a particular pilot may prefer to operate vessels in their own particular manner.

8.2.1 Navigation in the Port Manatee Channel

The pilots were familiar with the widener design, and some of those interviewed had participated in the WES ship simulation as part of the design process. Regarding the necessity of slack tide transits, the pilots considered the improved channel access/egress provided by the wideners and concluded that the same operational rules as currently employed would apply to vessels drawing more than 34 feet, rather than 27 feet per current practice. Therefore, under with-project conditions, vessels drawing between 27 and 34 feet would be able to operate in an unconstrained manner. Larger vessels, such as those drawing more than 30 feet, currently must make the turn very slowly. These vessels would experience some time savings while making the turn at the channel junction. This time savings is incorporated into the transit times estimated for the alternative plans. In addition, the pilots anticipated that the wideners would reduce groundings at the channel junction by half (i.e., from 4 to 2 per year).

8.2.2 Navigation in the Harbor

In reviewing the turning basin alternatives, the pilots indicated that they would not affect Port operations for vessels smaller than 650 feet LOA. As noted previously, the pilots considered Alternative A-3 to be a marginal improvement over existing conditions. Dredging the tip of the shallow area adjacent to the current Berth 5 would be helpful to the pilots by allowing them to maintain a slightly higher speed down the channel with a consequent improvement in maneuverability in tidal cross-currents. With this alternative, they anticipated that they would continue to turn vessels larger than 650 feet LOA in three-point turns per current practice.

The pilots had the same perspective regarding Alternatives A-7 and A-4. Alternative A-7 would be a marginal improvement over Alternative A-3, and Alternative A-4 would be a marginal improvement over Alternative A-7. As for Alternative A-3, the pilots appreciated the higher speeds down the channel that would be possible with each alternative. However, they anticipated that they would continue to turn vessels larger than 650 feet LOA in three-point turns per current practice.

In considering the turning basin alternatives and the widening alternative, the pilots qualified their remarks as preliminary. Their operational responses to the navigation improvements would depend on the circumstances extant at that time. For example, the pilots left open the possibility of a rotational turn of larger vessels (i.e., > 650 feet LOA) in the turning basin with Alternatives A-3 and A-7. Alternative A-4 was noted as being more attractive than A-3 and A-7 for this maneuver.

When asked about operational assumptions to be included in the port simulation model, the pilots considered Alternatives A-3 and A-7 to be essentially equivalent in terms of time savings. They also considered Alternatives A-4 and A-6 to be essentially equivalent, recognizing the increased margin for error in turning basin operations that would be afforded to the pilots by the larger plans of each equivalent pair. "Error" in this case refers to possible mistakes that could result in additional time-consuming maneuvers, rather than mistakes that could result in accidents or losses of any sort.

Recognizing the variety of parameters affecting ship and port operations at any given time, the pilots summarized the effects of the turning basin alternatives in terms of time saved for ship and tugs in the passage in/out between the channel entrance and berth. For vessels over 650 feet LOA, the transit time is typically 2 hours. According to the pilots, Alternatives A-3 and A-7 would likely reduce the transit time to 1.25 hours. For existing conditions and for Alternatives A-3 and A-7, if a ship is docked at Berth 6 or Berth 11, an additional 15 minutes would be required. According to the pilots, Alternatives A-4 and A-6 would reduce the transit to one hour, and the presence of a vessel at Berth 6 or Berth 11 would not increase the time required under Alternative A-4 or Alternative A-6.

9. COSTS USED IN THE ANALYSIS

As indicated above, the only economic benefits quantified in this analysis are benefits that can be estimated with a reasonable level of certainty. The primary benefits expected to result from the alternative plans are the transportation cost savings resulting from reductions in: (1) delays for large vessels and assisting tugs entering the Port Manatee due to operational constraints posed by tidal currents and (2) transit time for large commercial vessels and assisting tugs from the Channel entrance to/from berth at Port Manatee. As explained in the description of the transportation cost model in the following section, the model calculates transportation costs associated with queuing delays, diversion of vessels to other ports, in-port vessel shifts, and other associated minor costs. Hourly vessel operating costs for self-propelled vessels (both in-port and at-sea) were taken from the tables and regressions provided in Economic Guidance Memorandum 02-06, Deep Draft Vessel Operating Costs, adjusted to 2003 levels. Operating costs for barges were taken from Economic Guidance Memorandum 00-05, Shallow Draft Vessel Operating Costs, in lieu of ocean-going barge costs. Table 12 shows the hourly vessel operating costs used in this analysis. Additional cost data used in the analysis are based on interviews with Port Manatee personnel, shipping agents, and carriers. Costs used in the analysis are discussed below.

Vessel Waiting Costs. The costs associated with waiting to enter a berth equal the number of hours waiting in the queue multiplied by the average hourly in-port costs for the particular type of vessel waiting. The amount of time spent waiting in the queue is calculated as the date/time entered the off-shore anchorage minus the date/time the vessel left the offshore anchorage. Although the vessel waits at a sea anchorage for an available berth, in-port costs were used to estimate costs of vessels at anchor.

Vessel Transit Costs. The costs associated with transiting from the Channel entrance to/from berth are not consistent with either at-sea or in-port costs. While transiting the channel, the vessel is not at a dead stop; nor is it traveling at the same speed it would be in open waters. The level of fuel consumption is therefore probably somewhere in between that assumed for the in-port costs and that assumed for the at-sea costs. Consequently, a mid-point between the two costs was selected as the most reasonable proxy for channel transit.

Tug Assistance. Tug costs are based on tug rates charged by the principal vendor of tug services at Port Manatee. An average rate of $1,668 per 1 ½ hour time block was applied as a proxy for the cost of an ocean-going tug capable of maneuvering Panamax vessels.

Steaming Costs for Diverted Vessels. The costs associated with steaming to another port equal the number of hours steaming multiplied by the average hourly at-sea costs associated with the particular type of vessel diverted. Diversion destination ports were identified by carriers and port personnel as the port historically used or most likely to be used when waiting time at Port Manatee is excessive. The diversion destination ports used in this analysis are ports that vessels have diverted to during recent excessive waiting time events or are ports that are known to be capable of servicing the carrier and cargo. Most carriers and vessels are diverted to Tampa, with the exception of Tropicana, Gear Bulk (forest products), and Del Monte (fresh fruit) vessels.

The amount of time spent steaming was determined to equal 26 hours for Tropicana ships diverted to Canaveral, Florida, 40 hours for Forest Products vessels diverted to Fernandia Beach, Florida, 52 hours for Fresh Fruit ships diverted to Savannah, Georgia, and 48 hours for all other

Table 12: Vessel Costs

Ship Class	Ship Type	EGM 02-06 Designation	Hourly Costs	
			At Sea	In Port
Aggregate	Barge I	Barge	$ 634.62	$ 7.71
	Barge II	Barge	$ 634.62	$ 7.71
Asphalt	Barge I	Asphalt barge	$1,412.44	$ 33.33
	Barge II	Asphalt barge	$1,494.74	$ 33.33
	Self-propelled I	US tanker	$1,720.98	$ 1,566.43
Bag Fertilizer	Barge I	Barge	$ 634.62	$ 7.71
Bunker	Barge I	Barge Tanker	$1,064.62	$ 20.83
	Barge II	Barge tanker	$1,463.68	$ 20.83
	Barge III	Barge tanker	$1,525.79	$ 20.83
	Self-Propelled I	FF tanker	$ 746.79	$ 594.45
	Self-Propelled II	FF tanker	$ 953.06	$ 753.62
	Self-Propelled III	US tanker	$1,956.88	$ 1,774.17
	Self-Propelled IV	US tanker	$2,161.67	$ 1,957.61
Cement	Self-Propelled I	Barge	$ 564.04	$ 406.27
	Self-Propelled II	Barge	$ 605.79	$ 436.17
Clinker	Self-Propelled I	FF Gen Cargo	$ 596.01	$ 421.09
	Self-Propelled II	FF Gen Cargo	$ 609.64	$ 438.93
Juice Concentrate	Self-Propelled I	FF tanker	$ 716.00	$ 572.54
	Self-Propelled II	FF Tanker	$ 707.06	$ 566.18
Diesel	Barge I	Barge Tanker	$1,552.19	$ 20.83
	Self-Propelled I	US tanker	$1,748.15	$ 1,590.89
Dolomite	Barge I	Barge	$ 634.62	$ 7.71
	Barge II	Barge	$ 634.62	$ 7.71
Fertilizer	Barge I	Barge	$ 634.62	$ 7.71
	Barge II	Barge	$ 634.62	$ 7.71

Table 12: Vessel Costs				
Ship Class	Ship Type	EGM 02-06 Designation	Hourly Costs	
			At Sea	In Port
	Self-Propelled I	FF Gen Cargo	$ 470.11	$ 344.11
	Self-Propelled II	FF Gen Cargo	$ 596.01	$ 429.17
	Self-Propelled III	FF Gen Cargo	$ 735.66	$ 527.01
Forest Products	Self-Propelled I	FF Bulker	$ 410.45	$ 332.91
	Self-Propelled II	FF Bulker	$ 544.87	$ 393.56
	Self-Propelled III	FF Bulker	$ 592.57	$ 426.71
	Self-Propelled IV	FF Bulker	$ 649.90	$ 468.70
Fruit	Self-Propelled I	FF Gen Cargo	$ 474.39	$ 363.52
	Self-Propelled II	FF Gen Cargo	$ 663.63	$ 494.41
Granite	Self-Propelled I	FF Gen Cargo	$ 979.76	$ 727.64
Limestone	Self-Propelled I	FF Gen Cargo	$ 728.13	$ 521.53
Linerboard	Self-Propelled I	FF Gen Cargo	$ 450.82	$ 349.87
	Self-Propelled II	FF Gen Cargo	$ 692.53	$ 515.65
Miscellaneous	Self-Propelled I	FF Gen Cargo	$ 373.19	$ 304.90
	Self-Propelled II	FF Gen Cargo	$ 761.37	$ 565.59
	Self-Propelled III	FF Gen Cargo	$ 979.76	$ 727.64
Juice Not Concentrate	Self-Propelled I	FF Gen Cargo	$ 583.37	$ 435.44
	Self-Propelled II	FF Gen Cargo	$ 580.16	$ 433.08
Other	Barge I	Barge	$ 634.62	$ 7.71
	Barge II	Barge	$ 634.62	$ 7.71
	Self-Propelled I	FF Gen Cargo	$ 357.94	$ 296.06
	Self-Propelled II	FF Gen Cargo	$ 809.93	$ 600.76
Cruise Passengers	Cruise Vess	US tanker	$1,760.50	$ 1,602.01
Steel	Barge I	Barge	$ 634.62	$ 7.71
	Self-Propelled I	FF Gen Cargo	$ 673.26	$ 501.49

ship types diverted to Tampa. The steaming times to Tampa also include the potential for waiting during safety zone operations at Tampa Bay. These steaming times account for the possibility that the vessel might have waited at Port Manatee prior to diversion and/or that the vessel waited at the other port due to the short arrival notice. Vessels are diverted only when the cost of diversion is less than the cost of waiting, i.e., when diversion is a lower cost alternative.

The steaming costs for diverted vessels does not include costs related to additional over-land (road or rail) travel required to get cargo to its final destination or time required to get goods back to Port Manatee when Port Manatee is the final destination (for example, vessels often carry cargo in addition to the main cargo, such as a small number of containers, that are often destined for local delivery in the vicinity of Port Manatee).

Vessel In-Port Operating Costs. Operating costs while in port equal the time spent in port multiplied by the average hourly in-port costs for the particular type of vessel docked. The amount of time spent in port equals the vessel's departure time minus its time of arrival at a berth (minus the equipment setup and breakdown time). In-port operating costs are also applied to diverted vessels when they reach their ultimate destination. For vessels diverted to Canaveral, Fernandia Beach and Savannah, extra port costs are assumed in the amount of 24 hours times the average hourly IWR in-port costs described earlier. This additional cost accounts for the fact that arrival at a diversion destination is an unscheduled arrival that would be expected to impact local port productivity through increased time spent loading and unloading or through the employment of additional resources to load and unload the diverted vessel.

Port Fees. Vessels docked at a Port Manatee berth are assessed a port fee of $4,500 per day. This fee is assessed when a vessel arrives at a berth, and again at midnight every day that the vessel remains in the berth.

Vessel In-Port Shift Costs. In this analysis, these costs are incurred when Tropicana's vessels move from Berth 8 (Tropicana's preferred berth, as it is adjacent to its chilled warehouses) to Berth 9 in order to accommodate a Cement vessel waiting to enter Berth 8 (the only berth with facilities to discharge Cement vessels). Extra costs of $17,000 are incurred, primarily for additional pilot and stevedoring expenses. These costs are charged (and therefore assigned) to the Cement vessels.

Vessel In-Port Sub-Optimal Productivity Costs. These costs are incurred when a vessel cannot dock at its preferred berth. Preferred berths are typically the berth best suited for efficient loading and off-loading of vessel cargo. Typically the preferred berth is adjacent to or in close proximity to the warehouses and off-loading equipment used by that type of ship. If a berth other than the preferred berth is used, additional equipment, labor, and time is often required. Interviews with port and carrier personnel indicate that docking at a non-preferred berth imposes additional in-port costs related to additional equipment and labor employed and additional time spent loading and unloading. Although these additional costs are acknowledged by the carriers and port officials, there are no data available to quantify these specific costs apart from total in-port costs. Based on discussions with Port operations personnel and tenants, an additional 5 percent of time to load or unload is used to address vessel in-port sub-optimal productivity costs. Also on the basis of these discussions, when a vessel is modeled as docking at a non-preferred berth an additional 5 percent of cost to load or unload is assigned to that vessel call to account for productivity losses associated with the non-preferred berth.

10. SIMULATION MODEL

The National Economic Development (NED) analysis of wideners and turning basins at Port Manatee uses the commodity forecasts, vessel characteristics, number of calls, and vessel and Port operating costs described previously to estimate transportation costs under with- and without-project conditions. The forecasts of these future conditions are used as inputs to the transportation cost model. The discounted cost savings of the alternative plans relative to the without-project condition throughout the period of analysis represent the benefits of the alternative channel wideners and turning basin combinations.

At the most basic level, the benefit estimation method is simply an assessment of the difference in transportation costs between the without-project condition and alternative with-project conditions. Typically, transportation cost savings are identified as a significant source of benefits through the use of larger and more efficient vessels in the calling fleet. In this analysis of Phase II navigation improvements at Port Manatee, the major source of benefits lies in the reduction of vessel, tug, and port costs associated with: (1) tidal delays as large vessels wait to enter the Port Manatee Channel and (2) transit times for vessels passing to/from the Channel entrance and berth.

Port Manatee does not maintain formal records or data that describe ship delays, the number of vessel calls diverted to other ports, or vessel in-port shifts due to berth congestion at the port. A simulation model was developed to incorporate into the benefits analysis the following operational and cost parameters: frequency and pattern of vessel arrivals, tidal delays experienced, channel transit time, berth availability, vessel berth preferences, berth set-up and break-down time, and the likelihood of diversion.

10.1 Model Overview

The Port Manatee simulation model analyzes the costs of delays associated with large vessels waiting for slack tide at the entrance to the Port Manatee Channel and costs associated with time required to transit the channel from entrance to/from berth. The model also simulates vessel traffic congestion in terms of vessel delay, diversion, port, and stevedoring costs. Model runs were conducted for a 20-year period under with- and without-project conditions using the analytical inputs described above.

The model is an hour-by-hour simulation of port activity through the period of analysis. Model iterations are made in one hour increments for each year of the forecast period, simulating vessel arrival and departures in each hour every year, for twenty years. Model inputs and individual steps are described below.

10.2 Model Inputs

Port operational constraints, fleet forecasts, and transportation costs developed as part of this analysis served as the primary inputs to the simulation model. In addition, commodity/vessel frequency distributions and vessel/commodity berthing preferences were developed as part of the model. These inputs are discussed below.

10.2.1 Slack Tide Delays

As explained in the descriptions of with- and without-project conditions, the following vessels must wait for slack tide conditions prior to entering the Port Manatee Channel: (1) without-project conditions (i.e. without wideners): those with drafts in excess of 27 feet and (2) with-project conditions (i.e. with wideners): those with drafts in excess of 34 feet.

10.2.2 Channel Transit Times

As discussed under the without-project navigation discussion, it is assumed that vessels over 650 feet LOA would require two hours to transit the channel. Alternatives A-3 and A-7 would likely reduce the transit time for these vessels to 1.5 hours, primarily by allowing higher speeds down the channel. Alternatives A-4 and A-6 would further reduce the transit to 1.25 hours by allowing higher transit speeds and faster turns. For Alternatives A-3 and A-7, it is assumed that if a ship is docked at Berths 6 or 11, an additional 15 minutes would be required, resulting in a transit time of 1.5 hours. It is assumed that vessels under 650 feet LOA can transit the channel in one hour.

10.2.3 Vessel/Commodity Frequency Distributions

One of the primary assumptions of the model is that no more than one vessel will arrive in any given hour. Based on the fleet forecasts discussed above, 540 vessels are anticipated to call at Port Manatee in 2005 under with-project conditions. The probability that a vessel would call at Port Manatee during any hour throughout that year under with-project conditions was therefore set at 6.1644 percent (540 vessels /8760 hours per year). For each year of the simulation, the hourly probability of vessels arriving was calculated in a similar fashion, using calls anticipated for each individual year.

10.2.4 Berth Preferences and With-Project Constraints

Many of the vessels that call at Port Manatee can only utilize certain berths, and nearly all port tenants have a preferred berth. Through discussions with port tenants, port personnel and an examination of vessel call data, preferred berths were assigned to each vessel/commodity class, and are shown on Table 13 (along with frequency distribution information discussed above) for without-project conditions. Data under with-project conditions are shown on Table 14. As shown in the tables, most vessel/commodity types can dock at more than one berth throughout the port, while others can dock at only one berth. For example, Table 13 shows that Del Monte prefers to dock its ships (ship types Fruit Self-Propelled I & II) at Berth 11, because their warehouses are located adjacent to this berth. However, these vessels may also use Berths 10 and 9. This table also shows that specific vessel/commodity classes can anchor only at specific berths (Cement Self-Propelled vessels, Clinker Self-Propelled vessels, and Fertilizer Self-Propelled vessels), as discussed in the earlier section on port operating practices and constraints.

10.3 Model Execution

The simulation model computes the transportation costs for all vessels that are projected to call at Port Manatee over the 20-year projection period. Forecasts of vessel calls, costs, berthing preferences, berth setup and breakdown times, and the likelihood of diversion costs are all analyzed to determine transportation costs for both with- and without-project alternatives. Execution of the model consists of seven steps.

Step 1: Predict the 20-year Vessel Arrival Pattern,

Step 2: Simulate Vessel Arrivals,

Step 3: Examine Berths for New Vacancies,

Step 4: Process the Vessels Waiting in the Queue,

Step 5: Determine Which Vessels are Diverted,

Step 6: Assign Costs to Vessels,

Step 7: Advance the Time Counter.

Table 13: Year 2005 Commodity/Vessel Frequencies and Preferred Berths Without-Project Conditions								
Commodity Type	**Ship Type**	**Weight**	**Cumul Freq**	**Preferred Berth**				
				1	**2**	**3**	**4**	**5**
Aggregate	Barge I	0.0054	0.0054	5	7			
	Barge II	0.0007	0.0061	5	7			
Asphalt	Barge I	0.0003	0.0064	7	8			
	Barge II	0.0006	0.0070	7	8			
	Self-Propelled I	0.0001	0.0071	7	8			
Bag Fertilizer	Barge I	0.0002	0.0073	7	8	9		
Bunker	Barge I	0.0011	0.0084	10	9	6	7	8
	Barge II	0.0022	0.0106	10	9	7		
	Barge III	0.0017	0.0123	10	9	7		
	Self-Propelled I	0.0001	0.0124	10	9			
	Self-Propelled II	0.0008	0.0132	10	9			
	Self-Propelled III	0.0002	0.0135	10	9			
	Self-Propelled IV	0.0018	0.0153	10	9			
Cement	Self-Propelled I	0.0006	0.0159	8				
	Self-Propelled II	0.0007	0.0166	8				
Clinker	Self-Propelled I	0.0008	0.0174	6				
	Self-Propelled II	0.0007	0.0180	6				
Juice Concentrate	Self-Propelled I	0.0001	0.0182	6	9	8		
	Self-Propelled II	0.0009	0.0191	6	9	8		
Diesel	Barge I	0.0010	0.0201	10	9	8	6	
	Self-Propelled I	0.0003	0.0204	10	9	8	6	
Dolomite	Barge I	0.0014	0.0218	5	7			
	Barge II	0.0047	0.0265	5	7			
Fertilizer	Barge I	0.0002	0.0267	7				
	Barge II	0.0001	0.0268	7				
	Self-Propelled I	0.0030	0.0298	7				
	Self-Propelled II	0.0030	0.0328	7				
	Self-Propelled II	0.0022	0.0349	7				
Forest Products	Self-Propelled I	0.0016	0.0365	8	9	7	10	
	Self-Propelled II	0.0008	0.0373	8	9	7	10	
	Self-Propelled III	0.0022	0.0395	9	8	7		
	Self-Propelled IV	0.0002	0.0397	9	8	7		
Fruit	Self-Propelled I	0.0030	0.0427	11	10	9		

Table 13: Year 2005 Commodity/Vessel Frequencies and Preferred Berths Without-Project Conditions								
Commodity Type	**Ship Type**	**Weight**	**Cumul Freq**	**Preferred Berth 1**	**2**	**3**	**4**	**5**
	Self-Propelled II	0.0047	0.0474	11	10	9		
Granite	Self-Propelled I	0.0001	0.0475	6	8	9		
Limestone	Self-Propelled I	0.0025	0.0500	6	8	9		
Linerboard	Self-Propelled I	0.0013	0.0513	11	10	9		
	Self-Propelled II	0.0007	0.0519	11	10	9		
Miscellaneous	Self-Propelled I	0.0030	0.0549	9	8	7	10	
	Self-Propelled II	0.0002	0.0551	9	8	7	10	
	Self-Propelled III	0.0002	0.0554	9	8	7	10	
Juice Not Concentrate	Self-Propelled I	0.0010	0.0564	8	9			
	Self-Propelled II	0.0007	0.0571	8	9			
Other	Barge I	0.0001	0.0572	5	7	8		
	Barge II	0.0001	0.0573	5	7	8		
	Self-Propelled I	0.0009	0.0582	7	6	8	9	
	Self-Propelled II	0.0003	0.0586	7	6	8	9	
Passengers	Cruise V	0.0045	0.0630	9	10	8		
Steel	Barge I	0.0001	0.0631	9	10			
	Self-Propelled I	0.0005	0.0636	9	10			
No Vessels		0.9364	1.000000					

Table 14: Year 2005 Commodity/Vessel Frequencies and Preferred Berth With-Project Conditions								
Commodity Type	**Ship Type**	**Weight**	**Cumul Freq**	**Preferred Berth 1**	**2**	**3**	**4**	**5**
Aggregate	Barge I	0.0054	0.0054	5	7			
	Barge II	0.0007	0.0061	5	7			
Asphalt	Barge I	0.0003	0.0064	7	8			
	Barge II	0.0006	0.0070	7	8			
	Self-Propelled I	0.0001	0.0071	7	8			
Bag Fertilizer	Barge I	0.0002	0.0073	7	8	9		
Bunker	Barge I	0.0011	0.0084	10	9	6	7	8

Table 14: Year 2005 Commodity/Vessel Frequencies and Preferred Berth With-Project Conditions

Commodity Type	Ship Type	Weight	Cumul Freq	Preferred Berth 1	2	3	4	5
	Barge II	0.0022	0.0106	10	9	7		
	Barge III	0.0015	0.0121	10	9	7		
	Self-Propelled I	0.0001	0.0122	10	9			
	Self-Propelled II	0.0007	0.0129	10	9			
	Self-Propelled III	0.0002	0.0131	10	9			
	Self-Propelled IV	0.0017	0.0148	10	9			
Cement	Self-Propelled I	0.0006	0.0154	8				
	Self-Propelled II	0.0007	0.0161	8				
Clinker	Self-Propelled I	0.0008	0.0169	6				
	Self-Propelled II	0.0006	0.0175	6				
Juice Concentrate	Self-Propelled I	0.0001	0.0176	6	9	8		
	Self-Propelled II	0.0009	0.0185	6	9	8		
Diesel	Barge I	0.0010	0.0195	10	9	8	6	
	Self-Propelled I	0.0003	0.0199	10	9	8	6	
Dolomite	Barge I	0.0014	0.0212	5	7			
	Barge II	0.0047	0.0259	5	7			
Fertilizer	Barge I	0.0002	0.0261	7				
	Barge II	0.0001	0.0263	7				
	Self-Propelled I	0.0030	0.0292	7				
	Self-Propelled II	0.0026	0.0318	7				
	Self-Propelled II	0.0018	0.0337	7				
Forest Products	Self-Propelled I	0.0016	0.0353	8	9	7	10	
	Self-Propelled II	0.0008	0.0361	8	9	7	10	
	Self-Propelled III	0.0018	0.0379	9	8	7		
	Self-Propelled IV	0.0002	0.0381	9	8	7		
Fruit	Self-Propelled I	0.0030	0.0411	11	10	9		
	Self-Propelled II	0.0047	0.0458	11	10	9		
Granite	Self-Propelled I	0.0001	0.0459	6	8	9		
Limestone	Self-Propelled I	0.0022	0.0481	6	8	9		
Linerboard	Self-Propelled I	0.0013	0.0493	11	10	9		
	Self-Propelled II	0.0007	0.0500	11	10	9		
Miscellaneous	Self-Propelled I	0.0030	0.0530	9	8	7	10	
	Self-Propelled II	0.0002	0.0532	9	8	7	10	

Table 14: Year 2005 Commodity/Vessel Frequencies and Preferred Berth With-Project Conditions								
Commodity Type	Ship Type	Weight	Cumul Freq	Preferred Berth 1	2	3	4	5
	Self-Propelled III	0.0002	0.0534	9	8	7	10	
Juice Not Concentrate	Self-Propelled I	0.0010	0.0545	8	9			
	Self-Propelled II	0.0007	0.0551	8	9			
Other	Barge I	0.0001	0.0553	5	7	8		
	Barge II	0.0001	0.0554	5	7	8		
	Self-Propelled I	0.0009	0.0563	7	6	8	9	
	Self-Propelled II	0.0003	0.0566	7	6	8	9	
Passengers	Cruise V	0.0045	0.0611	9	10	8		
Steel	Barge I	0.0001	0.0612	9	10			
	Self-Propelled I	0.0005	0.0616	9	10			
No Vessels		0.9384	1.000000					

Step 1: Predict the 20-Year Vessel Arrival Pattern

The first step of the modeling process is to create a vessel arrival schedule for all 20 years in the forecast period. Generation of the predicted arrival pattern is a two-step process. The first step is to determine the hours when any type of vessel is scheduled to arrive during the 20 year forecast period. The second step is to determine, for each hour with a scheduled arrival, which type of vessel will arrive.

For each year, the probability of arrival is calculated as the total number of predicted calls for that year divided by 8,760 hours (365 days times 24 hours). As explained above, for the base year (2005), that probability equals 6.1644 percent (540 vessels /8760 hours per year). For the first hour of the first year, a random number is generated between 0 and 1. If the random number is less than or equal to 5.5 percent it is assumed that a vessel (of any type) will arrive and a notation is made that a vessel will arrive during this hour. If the random number is greater than 5.5 percent, it is assumed that no ship will arrive and no notation is made for the hour. This process is repeated 8,759 times to determine for which of the 8,760 hours during the first year a ship will arrive in port. A new probability is calculated for year 2, and the process begins again. At the end of 20 years, the result is a table that lists all hours over the 20 years of observation during which a ship is scheduled to arrive. Figure 2 provides a flow chart of this process.

A frequency distribution is then calculated for year 1, based on the number of each type of ship that is scheduled to arrive during the year. The cumulative probability for all ship types is equal to 100 percent. For each of the hours identified above (when a ship is scheduled to arrive in port), a new random number is generated between zero and 1. This probability is then compared to the frequency distribution to determine which type of ship will arrive at that hour. Figure 3 provides a flow chart of this process.

For example, consider the simplifying assumption that there are only three ship types projected to call during the first year: Fertilizer, Cement and Clinkers. The projected calls are 10

Fertilizer ships, 20 Cement ships and 30 Clinker ships. So for any given hour when a vessel is scheduled to arrive, there would be a 16.67 percent probability that the arriving ship is a Fertilizer ship, a 33.33 percent probability that the arriving ship is a Cement ship, and a 50 percent probability that the arriving ship is a Clinker ship.

New frequency distributions are calculated for each of the twenty years, based on the projected call patterns for each year. The result is a table that holds the hours during which a ship is scheduled to arrive, as well as the type of ship that is scheduled to arrive at each hour over a twenty year period.

As noted above, Passenger ships only arrive at Port Manatee from December through May. In order to maintain data integrity, the arrival prediction methodology described above is actually done in two steps. For hours during the year that occur in the months of January, February, March, April, May or December (hours 1 through 3,624 and 8,017 through 8,760 in Year 1) one set of probabilities is used to identify the type of ship that is scheduled to arrive at port at a given hour. This set of probabilities includes all projected Passenger vessel calls for the entire year. During the remaining hours of a given year (corresponding to June through November), a separate set of probabilities is used, and this set does not include any Passenger vessel calls.

Step 2: Simulate Vessel Arrivals

At the start of every hour (beginning with the first hour of January 1st), the vessel arrival table is examined to determine whether a vessel is scheduled to arrive at that hour. If a vessel has been selected by the model to enter the Port Manatee System, it enters a "Ships Waiting" queue. At this time, a notation is made of the year and hour of arrival at port, and a unique identification number is assigned to the vessel. Vessels will remain in the "Ships Waiting" queue either until a suitable berth becomes available, or until they are diverted to another port.

When a vessel arrives, the model calculates the approximate time required to transit the channel. Vessels longer than 650 feet LOA are assumed to require two hours to transit under without-project conditions; smaller vessels are assumed to require one hour. It also compares the draft of the vessel to the operational rules regarding vessels that must wait for a slack tide (i.e., without-project conditions: vessels with drafts greater than 27 feet must wait for slack tide; with-project conditions: vessels with drafts greater than 34 feet must wait). The model checks a tide simulation table to determine the number of hours each vessel may be delayed (with associated delay costs).

Step 3: Examine the Berths for Exit Activity and New Vacancies

This model step is executed for each hour of the simulated year, whether or not a new vessel has arrived during the hour. Each berth is examined each hour to determine if any vessels currently occupying berths are scheduled to depart by the model (see Step 4 below). This is accomplished by comparing the anticipated departure time for each ship at a berth with the current model hour.

Vessels can leave berth if: (1) the model clock is greater than or equal to the expected departure time, (2) there is no vessel currently in the channel, and (3) there would not be two 36-foot vessels traveling during a single slack tide. If there is more than one vessel ready to leave at a given hour, the model selects the vessel that has been at berth the longest, since only one can transit at a time. When a vessel leaves berth, the model accounts for channel traffic using transit times consistent with Step 2.

If a vessel is scheduled to depart at the simulated hour, all data associated with that vessel is copied to an output file and the berth that the vessel occupied is designated as vacant. If no vessels are scheduled to depart, the berth occupancy table is unchanged.

Step 4: Process the Ships in Queue

This model step, which identifies the ships that are ready to move into a berth, is also executed for each hour of the simulated year. Before the model checks to see whether a berth is available, it checks: (1) whether the vessel can travel at that hour (depending on whether it must wait for a slack tide), (2) whether there is another vessel already present in the channel, and (3) whether the movement of the vessel in question would result in two 36-foot vessels traveling during a single slack tide.

Ships waiting for a berth are considered for movement based on the order of arrival at the port, after taking into account the following priority rankings. Passenger ships get first priority, followed by vessels with perishable cargo (fruit and juice), followed by vessels that can only use one area of the port (Cement, Clinkers, Bunkers, and Fertilizer), followed by all other ship types. Within each priority grouping, the order of consideration is based on the order of arrival at port. For the first vessel in the prioritized list of "Ships waiting" the model checks the availability of that ship type's preferred berth. If the vessel's preferred berth is available, the model checks the port processing rules. If there are no obstacles, the vessel is moved into its preferred berth. If the preferred berth is not available, the model checks the availability of the second through fifth choice berths. If there are no berths available for a specific ship (either because the berths are closed or the processing rules prevented the vessel from entering an available berth), then the model moves on to the next ship waiting in the "Ships Waiting" table.

When a vessel starts to travel up the channel, the model notes the time that the channel is occupied using transit time requirements consistent with Step 2. The time of arrival at berth is calculated as the time they enter the channel plus the transit time (Step 2).

If a vessel is moved into a berth, then a notation is made of the time of arrival at the berth. At this time, the anticipated departure time, costs while waiting and costs in port are also calculated, as described below.

Calculate Time Spent at Berth

When a vessel arrives at a berth, the model calculates its anticipated departure time, based on a number of factors.

1. The base number of hours equals the average amount of time spent at a berth for that ship type, based on 32 months of historic data. These data are collected by the Port Authority for billing purposes, and the actual time at berth equals the amount of time that elapses between the moment that the vessel is tied up at the berth and the moment that it is untied.

2. When a vessel cannot dock at its preferred berth, the number of hours spent at the berth is increased by 5 percent to account for extra equipment or transportation time. There is an additional 5 percent cost penalty associated with sub-optimal landside productivity. As noted in Section 9, these adjustments are based on interviews with Port Manatee personnel, shipping agents, and carriers.

3. The model assumes that berth operations do not begin until 7AM, so a vessel must wait extra hours if it arrives after midnight but before 7AM. For example, if a vessel arrives at 4AM, then the anticipated departure time is advanced by 3 hours.
4. For Cement ships, an additional 96 hours is added to the time at berth for Cement Hopper setup and breakdown before and after the vessel is in berth. As indicated by Port Manatee personnel and tenants, during this time no other vessel may use the berth for any purpose. Discussions with Port personnel and tenants also revealed that physical and manpower limitations prevent them from speeding up the process of setting up or breaking down the equipment, even if there is another vessel waiting for the berth. There are no costs associated with these hours, since the vessel is not actually at the berth, but the model prevents the berth from being designated as vacant during setup and breakdown time. When one Cement ship is replaced by another Cement ship, then the equipment time is decreased to 24 hours.
5. For Tropicana ships, an additional 60 hours is added to the time at berth for shoreside equipment setup and breakdown before and after the vessel is in berth. Again, this threshold is based on interviews with Port Manatee personnel, shipping agents, and carriers. As indicated above, no vessel may use the berth during this time, nor is there any way to speed up the shoreside process when another vessel is waiting for the berth. When one Tropicana ship replaces another, the additional time is decreased to 15 hours.

Therefore, the anticipated departure time for a vessel arriving at a berth is equal to: the time of arrival at berth, plus the average time at berth for that ship type, plus five percent if the vessel is at a berth other than its preferred berth, plus any adjustment for arriving between midnight and 7AM plus any additional hours for equipment setup. The anticipated departure time is stored with the vessel, and a notation of the departure time is stored in the berths table to be analyzed in Step 3 described above.

Step 5: Determine Which Vessels Are Diverted to Another Port

At the end of each simulated hour, the model reviews the list of ships waiting to get into a berth to determine whether any have been waiting for more than 48 hours. If so, then those ships are removed from the list of ships waiting and moved to a table of ships that left port. The 48-hour threshold is based on interviews with Port Manatee personnel, shipping agents, and carriers. Because shipping agents typically call ahead when a vessel is expected to be diverted, vessels diverted in the model are not assigned waiting costs. All vessels except those carrying Bunker, Cement and Clinkers are moved after 48 hours. Based on interviews with Port personnel and tenants, vessels carrying these commodities would not be diverted to other ports.

Step 6: Assign Costs to Vessels

After a vessel is fully processed, costs are applied to each vessel based on the time associated with waiting, diversion (if applicable), in-port operating costs, and port fees. Additional costs for in-port shifts, productivity losses, tug assistance, and productivity losses also are recorded for each vessel. Costs include channel transit time and tug costs.

Channel Transit Costs

The model applies the following decision rules to vessels transiting the Port Manatee Harbor. Hourly costs are an average of at-sea and at-port costs to account for the slow vessel transit speeds.

- Without-Project Conditions:
    - If the vessel LOA exceeds 650 feet, transit time equals 2 hours.
    - If the vessel LOA is less than 650 feet, transit time equals 1 hour.
    - For vessels which exceed 650 feet LOA, if there is a vessel in either Berth 6 or Berth 11 at the time the vessel arrives at port, transit times are increased by an additional 15 minutes.
- With-Project Conditions: Alternatives A-3 and A-7:
    - If the vessel LOA exceeds 650 feet, transit time equals 1.5 hours.
    - If the vessel LOA is less than 650 feet, transit time equals 1 hour.
    - If there is a vessel in either Berth 6 or Berth 11 at the time the vessel arrives at port, transit times are increased by an additional 15 minutes.
- With-Project Conditions: Alternatives A-4 and A-6:
    - If the vessel LOA exceeds 650 feet, transit time equals 1.25 hours.
    - If the vessel LOA is less than 650 feet, transit time equals 1 hour.
    - The presence or absence of a vessel in either Berth 6 or Berth 11 at the time the vessel arrives at port does not affect transit times under these alternatives.

Tug Costs

The model applies the following decision rules to tugs assisting vessels in the Port Manatee Channel or in the harbor. The tug fee is the same whether a vessel is entering or leaving a berth

- Each 1.5 hour block of tug time costs $1,668.
- Any time over 1.5 hours costs an additional $250 per hour.
- Two tugs are in residence at Port Manatee. If a third tug must be called from another port in the Tampa Bay port complex, a fee of $1,350 is assessed for travel time and costs, in addition to the hourly costs.
- Under Without-Project Conditions:
    - Barges require one tug for one 1.5 hour block.
    - Vessels over 650 feet LOA require two tugs for more than 1.5 hours.
    - Vessels over 700 feet LOA require 3 tugs for more than 1.5 hours.
    - All other vessels require 2 tugs for one 1.5 hour block.
- Under Without-Project Conditions (all alternatives):
    - Barges require one tug for one 1.5 hour block.

- All other vessels require 2 tugs for one 1.5 hour block.

Step 7: Advance the Hour Counter by One Hour

At the end of each simulated hour the model clock is advanced one hour so that the iteration process can proceed to the next step. In all, the model is run for 175,200 iterations (24 hours per day for 365 days per year for 20 years).

The output of each simulation run is a table that provides cost data for each vessel calling at Port Manatee over the projection period. One table is produced for each scenario analyzed.

Figure 2: Vessel Call Frequency Flow Chart

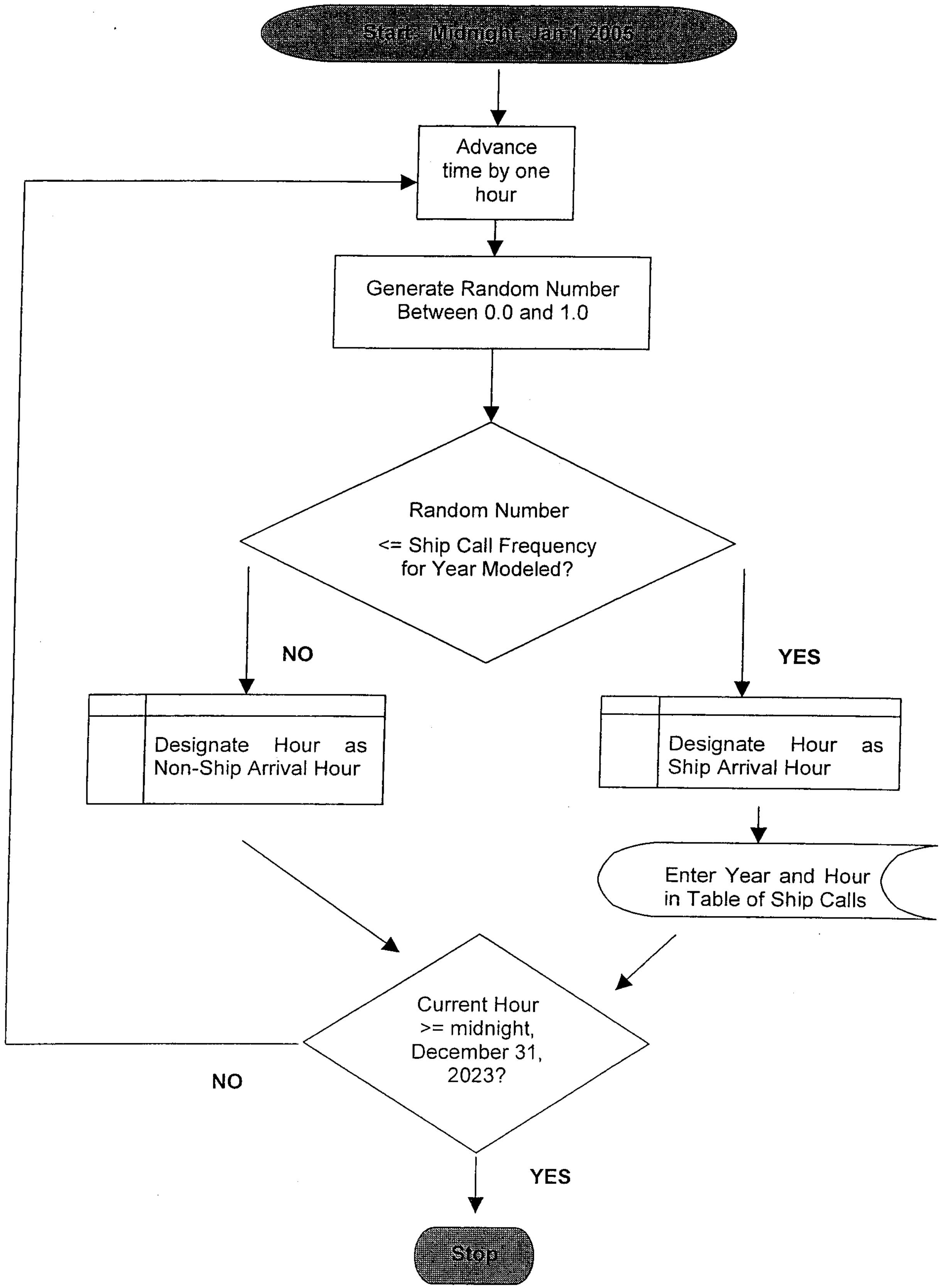
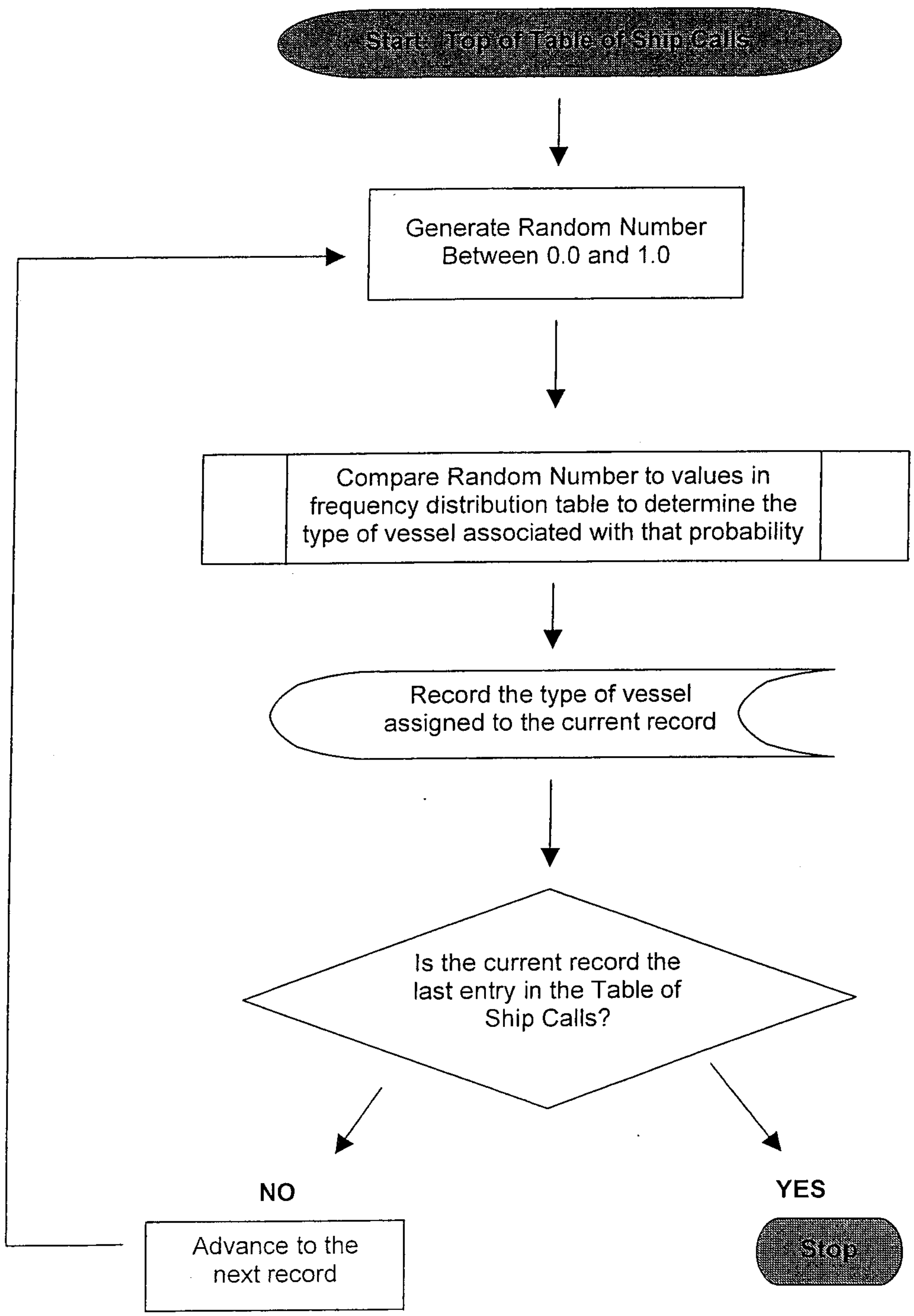


Figure 3: Vessel Type Call Pattern Flow Chart



11. ESTIMATE OF BENEFITS

Economic benefits considered in this analysis are National Economic Development (NED) benefits that increase the value of the national output of goods and services. Specifically, the benefits quantified in this analysis are the reduced costs of transportation realized through the Phase II navigation improvements, manifested as reductions in: tidal delays, transit times, and transit-related tug assistance.

Annual transportation cost savings for each alternative were calculated as the difference between transportation costs at Port Manatee under without-project conditions and under with-project conditions for the period of analysis (2005 – 2054). Table 15 presents the average annual equivalent benefits of the alternative plans, discounted at the current Federal discount rate of 5.875 percent. As indicated in this table, the benefits of two pairs of alternatives (A-3 and A-7; A-4 and A-6) are equivalent. As explained above, these equivalencies are based on similar transit time savings and associated costs savings expected to result from these two pairs of turning basin configurations. As indicated in Table 15, the average annual equivalent value of benefits for Alternatives A-3 and A-7 is $1,857,770, and the average annual equivalent value of benefits for Alternatives A-4 and A-6 is $1,875,130.

Table 15: Average Annual Equivalent Value of Transportation Benefits of the Alternative Plans

Alternative	Average Annual Equivalent Value of Benefits
Alternatives A-3 / A-7	$1,857,770
Alternative A-4 / A-6	$1,875,130

11.1 Sensitivity Analysis

A sensitivity analysis was performed to estimate the benefits of the alternative plans if Berth 5 is modified consistent with plans of MCPA. This modification would involve extension of the berth to 1,200 feet with a 40-foot draft (currently 350 feet with 20-foot draft). The improvement of Berth 5 would allow Vulcan Materials Company to relocate their operations to this berth. It would also reduce congestion in the Port by allowing other shippers to utilize the additional berth space and landside facilities.

Table 16 presents the results of a sensitivity analysis comparing the above without-project condition to a revised with-project condition that includes an expanded Berth 5 with associated operational changes in the Port. Specifically, as part of this simulation, it is assumed that Berth 5 would be the first choice of existing granite and limestone vessels, the second choice for miscellaneous tankers, and would remain the first choice for aggregate and dolomite barges.

The benefit estimates in Table 16 suggest that the modification of Berth 5 would significantly reduce transportation costs at Port Manatee, relative to the with-project conditions (Table 15). As evident in this table, the benefits expected to result from Alternative A-6 exceed those expected for Alternative A-4. According to the Tampa Pilots, Alternative A-6 would result in a

15-minute time savings for large vessels (i.e., over 650 feet LOA) arriving at Berth 5 relative tc the other turning basin alternatives.

Table 16: Average Annual Equivalent Value of Transportation Benefits with Berth 5 Expansion (Sensitivity Analysis)

Alternative	Average Annual Equivalent Value of Benefits
Alternatives A-3 / A-7	$2,324.290
Alternative A-4	$2,339,210
Alternative A-6	$2,344,260